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ANNALS OF SURGERY

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ORIGINAL MEMOIRS.

AN ANALYTICAL AND STATISTICAL REVIEW OF ONE THOUSAND CASES OF HEAD INJURY.

(*Concluded from vol. l, page 541.*)

BY CHARLES PHELPS, M.D.,
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V.—PUPILS.—The abnormalities of the pupils are so varied that they are best expressed in tabular form, as they were noted in those fatal cases of the second series in which necropsy was permitted. They are fully representative of the already published cases of the first series (*lib. cit.*).

Both pupils widely dilated	7
One pupil widely dilated	3
Both pupils fully or moderately dilated	22
One pupil fully or moderately dilated	19
Both pupils contracted	11
One pupil contracted	3
Normal	36
	101

A similar analysis of recovering cases in the same series affords, with allowance for their greater number, results not essentially different.

Both pupils widely dilated	7
One pupil widely dilated	2
Both pupils fully or moderately dilated	56
One pupil fully or moderately dilated	38
Both pupils contracted	17
One pupil contracted	7
Normal	147
	274

Percentages:

Normal pupils—Fatal cases	35%
Normal pupils—Recoveries	53%

It is probable that the percentage of normal pupils in recovering cases would be somewhat increased if the record had been complete; since in so large a number in which the pupils are unmentioned there is internal evidence that the normal condition was intended to be assumed.

While the percentage of normal pupils is thus much greater in recovering than in fatal cases, the difference is still insufficient in itself to be of value in prognosis. It may be said also in very general terms that the abnormal pupillary conditions in individual cases are of no material assistance in forecasting the result. Death and recovery ensue with both dilated and contracted pupils and whether reaction be lost, impaired, or unaffected. Recovery may follow even when dilatation is extreme and reaction entirely wanting, or death when both conditions are normal. It was thought by Mills [18] that "the more insensitive, dilated and immovable the pupils, the less favorable the prognosis." The analysis of these cases sustains this opinion in one particular. In the few cases in which dilatation was noted as extreme ten were fatal and nine recovered. The pupils were immovable in all the fatal cases, and with exceptions, were either normal or sluggish in reaction in those which recovered. The extremity of dilatation with complete fixation therefore may be considered of fatal import, though in one case of recovery, which is apparently exceptional, dilatation was extreme and reaction was entirely wanting as it was in several others in which dilatation was less complete. The danger, however, does not increase progressively with the extent of dilatation or of immobility. Death equally occurs with slight dilatation or none at all, or with contraction, and in either case with normal or but slightly impaired mobility; recovery occurs under the same conditions; and neither death nor recovery can be anticipated from the extent of dilatation or degree of fixation, except as stated when both together are removed to the farthest possible distance from the normal state.

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[18] Trans. Congress Am. Phys. and Surg., 1889, vol. i.

The phenomena of pupillary disturbance are many and varied. Their size may be symmetrically or unsymmetrically increased or diminished, and with an alteration in size either one or both may or may not be wholly, or in some lesser degree, without reaction to light or to accommodation or to both; or it may occasionally happen that with no alteration in size reaction may be wanting. The pupillary symptom, though usually primary may be secondary; or again it may change from time to time in the progress of the case; but whatever its nature or period of observance it has no characteristic relation to other symptoms with which it may be associated.

The abnormal pupil is indicative of intracranial lesion, though not necessarily of traumatism, and is so far diagnostic. It has been held in times past that all intracranial injuries were divisible into concussions and compressions; and lesions were ignored, except as to a recognition of bone, blood and pus as compressing agents; if it was concussion the pupils were contracted; if compression, they were dilated. If traumatisms are to be classified in accordance with pathogenic lesions, as better knowledge of their nature and greater accuracy of nomenclature now demands, it will be evident from the post-mortem examination of cases which have been cited that no pupillary condition is representative of any particular form of injury. Such an examination can lead to no conclusion except that any pupillary derangement, or none at all, may be associated with every form of intracranial injury, limited or diffuse, single or multiple, or implicating any cerebral area.

It was believed by Mr. Hutchinson that dilatation and fixation of a single pupil denotes a compression of the motor oculi communis nerve by a hemorrhage into the middle basal fossa of the same side. This explanation though perhaps true of a limited number of cases fails to be substantiated in the much larger number.

In 15 cases of the present series a single pupil was fully or moderately dilated and without reaction; and of these 4 were found to conform to Mr. Hutchinson's formula. The pupil was widely dilated in but 1 of the 4; in this an epidural clot covered the whole hemisphere and extended into the middle and posterior fossæ. In 3 cases in which dilatation was but moderate, hemorrhage in one filled the whole cranial cavity, in another occupied both middle fossæ, and in the third extended only beneath the frontal lobes. The remaining cases afforded no support to the Hutchinsonian contention. Two in which the pupil was widely dilated were cases of laceration; 5 with moderate unilateral dilatation disclosed extensive lesions, all of which were on the opposite side; and in the final 4 there was no basal hemorrhage.

Several other cases in which dilatation was slight may be neglected. The concomitant lesions were varied, but in no case included hemorrhage into the corresponding middle fossa.

There is an anatomical reason for admitting a direct relation to exist between the dilated pupil and the hemorrhage into the corresponding middle fossa; but there are also clinical reasons which compel the recognition of an equally positive, if less direct and obvious, relation between this pupillary change and every other form and site of intracranial lesion. The conclusion of Mr. Hutchinson would seem to have been another instance of too wide a generalization from too narrow a basis of observation.

Both pupils were widely dilated in 7 cases, and were irresponsive in all but one, and in this the reaction was limited to accommodation. In each a hemorrhage, epidural, pial, or cortical, was notable though in each with a single exception there was also laceration of importance. In 22 cases of less extreme dilatation the lesions were more varied. There was in 50 per cent. of these no hemorrhage at all, or none of importance, but a general contusion, pial or cerebral or both, with or without laceration or subarachnoid serous effusion. In several of the others in which hemorrhage was the most prominent lesion laceration was also a well marked feature. It follows that as hemorrhage was the most noteworthy lesion when dilatation was extreme, it was a general contusion when dilatation was of lesser extent.

There was contraction of a single pupil in only 3 cases, and in each the pupil was immovable. Large hemorrhages and a general contusion, which in one instance involved an extensive subcortical laceration, existed in all of them. In the 3 cases considered together all the basic fossæ, and the whole laterosuperior aspect of one hemisphere, were included in the hemorrhages.

In 11 cases, in which both pupils were contracted, hemorrhage was the prominent lesion in 3, general contusion in 6, and a co-existent hemorrhage and contusion in 2. As in unilateral contraction, there was no region of base or vertex which escaped some form of lesion.

The pupils were normal in size and reaction in a large percentage of all the cases examined. The lesions in these cases defy inductive analysis. They comprise all varieties of intracranial hemorrhage and involve every part of base and vertex; they include extreme contusions of both brain and meninges, and lacerations of all the cerebral ganglia except the respiratory and the cerebellum.

ILLUSTRATIVE CASES.

The only example in this series of a wide dilatation and fixation of a single pupil with hemorrhage into the corresponding middle fossa, as shown by necropsy, has been already quoted in illustration of asymmetrical radial pulsations. (Case XLIII—Pulse.)

Case LV.—*Wide Dilatation of a Single Pupil, with Recovery.*—A man was found at the foot of a stairway in a condition of stupor with widely dilated and irresponsive right pupil, profuse hemorrhage from the right ear, and frequent pulse and respiration. On admission to the hospital he was in shock, restless, and not wholly conscious; his right pupil was still dilated and irresponsive; and he had hæmatemesis, headache, and a lacerated wound in the left parietal region. He had no symptoms except headache after the day of admission.

Case LVI.—*Dilatation and Fixation of Right Pupil with Lesions Confined to Opposite Side. Necropsy.*—A man fell down stairs, a distance of fifteen feet, and was primarily unconscious. On admission to the hospital he was still unconscious with temperature 99°, pulse 90, and respiration 24. A wound in the right occipital region, was the only evident external injury. The right pupil was dilated and without reaction; the left radial pulse was fuller and more forcible than the right; vesical control was lost; and there was complete paralysis and anæsthesia of the right side. On the second day the movements of the leg were temporarily restored, both pupils became contracted and sensitive to light, temperature increased, and he became restless with some indications of consciousness, but not of intelligence. On the third day the mental condition was unchanged; loss of rectal and vesical control and asymmetry of the radial pulsations was continued, and right hemiplegia was again complete. Subconjunctival hemorrhage appeared in the left eye, and there were moist bronchial râles. He died on the fourth day, pulmonary œdema having increased, paralysis having become complete and unconsciousness more profound, and temperature having progressively risen to 107.6°.

Lesions.—Skull of great thickness and density; separation of left occipitoparietal and occipitotemporal sutures; fracture through left posterior basal fossa into foramen magnum; slight epidural hemorrhage on left side of internal occipital tuberosity; slight pial hemorrhage over left temporal lobe; thick cortical hemorrhage covering anterior border and base of left frontal lobe and first and second left temporal convolutions; subcortical laceration and excavation of whole left frontal, and anterior two-thirds of left temporal lobe; subcortical disintegration of left optic thalamus; small hemorrhage into left corpus striatum; and deep laceration across posterior border of left occipital lobe. Brain moderately hyperæmic.

Case LVII.—*Wide Dilatation and Fixation of Both Pupils. Recovery.*—A man was struck on the head by a tackle-block which had fallen about thirty feet. He was found by the ambulance surgeon unconscious, and with both pupils widely dilated and irresponsive to light or accommodation. On admission to the hospital his mental and pupillary conditions were unchanged; temperature 97.4°; pulse 92; respiration 26. He had an extensive and greatly comminuted fracture of the left parietal bone. The membranes were so lacerated that they were indistinguishable; much brain matter was lost; and portions of scalp, fragments of bone, hair and dirt were driven into the cerebral substance. The wound was cleansed and dressed, and in about one hour consciousness was restored. The pupils were still widely dilated and irresponsive. He vomited, and the bowels were moved by enema. Rectal and vesical control was subsequently lost and not regained for several days. The pupils did not begin to contract or to react till in the second month.

The history of this case is mainly one of mental decadence from left frontal lesion and has been described at length in a monograph published in the *American Journal of Medical Sciences,* May and June, 1902, Case IX,—and is again reproduced later in the consideration of left frontal lesions (Case LXXXIII) and of pupillary derangements (Case LVII).

VI.—The Loss of Rectal and Vesical Control.—

The term loss of control is used here comprehensively to indicate that disorder of the rectal and vesical sphincters which is manifest in ways generally known as incontinence of urine and fæces, and urinary retention. Fecal retention from atony of the rectum, due to local causes, is so common in all conditions of health and disease and so impossible to distinguish from a special form if such exist, corresponding to urinary retention that it must necessarily be ignored. Incontinence has been so often held to denote a relaxation of the sphincters which permits dribbling of urine or a continuous escape of fæces, that misapprehension might ensue if the same word were used to designate the very different condition which obtains in cases of intracranial injury. In default of a single word by which this condition may be expressed with exactitude the phrase loss of control has been substituted. As a matter of further convenience by a rhetorical license, it has been limited to the large majority of cases in which abnormal retention is not a feature; the latter to be considered later as a subdivision of the general subject.

In those cases of intracranial injury in which the rectal and vesical sphincters are involved there is in general neither muscular atony, paralysis, or spasm; but simply an automatic reflex action by which the urine or fecal matter is avoided independently of volition, either with or without the consciousness of the patient. The passage of urine differs from normal micturition in only one necessary particular, the absence of volition. It is usually discharged in practically normal quantity at practically normal intervals, whatever may be the nature of the intracranial lesion. Paralytic incontinence is usually the result of a neglect to relieve active retention, and as such has no claim to recognition as a symptom of injury. A relaxation of the sphincters may occasionally occur when unconsciousness is profound, but it is exceptional, and in nowise characteristic.

In a study of abnormal rectal and vesical conditions they were found to have been specifically noted in more than 350 cases. These cases, whether fatal or ending in recovery, comprised: those in which rectal and vesical control was lacking primarily or secondarily, separately or together; those in which urine was abnormally retained; and finally, those in which rectal and vesical functions were normally performed.

The statistical results of this examination of cases in which rectal or vesical control was lacking were as follows:

Recoveries	73
Deaths	154
	227
Necropsies	144
Primary Loss	123
Secondary Loss	104
	227
Loss of both Rectal and Vesical Control	111
Loss of Vesical Control Alone	102
Loss of Rectal Control Alone	14
	227

If to these cases there is added those of urinary retention, those in which death occurred too soon for urinary or fecal discharges to take place, and those in which it is specifically stated that these functions were normal, it will make the aggregate of 350 or more cases.

The large remainder of cases, somewhat less than 650, comprise those in which these functions failed of mention, either from neglect or because in the absence of mention their normal condition was intended to be assumed. It is probable that with a proper allowance for these cases the percentage of recoveries would be largely increased.

A recital in detail of the results of observation in the whole number of cases would be unnecessarily fatiguing, but the significance of such rectal and vesical disorders is sufficiently obscure and heretofore unconsidered to warrant some detail in analysis of at least those of the later cases in which symptoms could be confronted with lesions.

In 90 cases of the second series, in which necropsy was made, these rectal and vesical conditions had been noted:

Loss of both Rectal and Vesical Control	37
Loss of Vesical Control Alone	23
Loss of Rectal Control Alone	4
Abnormal Retention of Urine	11
No Fecal or Urinary Discharge	12
Normal Control retained till Death	3
	90

Primary control of both functions was retained in 16 cases, and in each the patient was conscious, and in 6 was without mental impairment. Twelve of these lost rectal or vesical control, or both, in from two to eleven days; and when the loss occurred on the second day it was always attended by stupor, unconsciousness, or delirium.

Primary loss of control was noted in 30 cases under varied mental conditions: Consciousness with normal mental state obtained in 2; stupor or delirium in 6; and unconsciousness in 22. Control was not regained in either of those primarily conscious, whether the mental state was normal or abnormal, and in only three of those primarily unconscious.

A loss of rectal or vesical control was as often secondary as primary, *i.e.,* was first noted at some time subsequent to the day on which the injury was received. In a certain number of these cases primary control is definitely stated in their history. In the larger number no mention is made of its presence or absence. In 50 per cent. of those in which such mention is neglected the patient was conscious; in 25 per cent. he was unconscious; and in 25 per cent. he was in stupor or delirium. The fact that in a large proportion of those cases in which this point in history failed of record on the first, it was noted on the second day would seem to suggest that there was neglect in noting the earlier condition. It may also be true that in the absence of note to the contrary its presence was meant to be inferred.

On the day when secondary loss of control was first noted the patient was usually unconscious, delirious or in some degree mentally incompetent. In 3 cases only was control regained; 2 of these were delirious primarily as well as when control was lost, when it was regained and when lost again, the third, in which rectal control alone was lost and at variable intervals, suffered progressive mental decadence. The lesions were respectively: moderate epidural and extensive pial hemorrhage, marked cerebral œdema, severe pial contusion with subarachnoid serous effusion; cortical hemorrhage from frontal lacerations; and great cerebral hyperæmia and œdema; and in the case last mentioned cerebral sclerosis and marked left frontal atrophy.

In more than 50 per cent. of the cases involved rectal and vesical control were lost together, and in all those remaining, save four, it was the bladder which was alone at fault; and when the bladder and rectum were successively, and not simultaneously affected, it was the bladder control which was usually lost primarily.

In 1 of the 4 exceptional cases, in which rectal control alone was lost, the patient was conscious until his death twelve hours after admission to the hospital; in another he was slightly delirious, and control was lost on the second day, death occurring on the third; in a third case, the patient who was then delirious required catheterization on the second day, voided urine naturally on the third, lost vesical control on the fourth, lost both rectal and vesical control on the fifth, regained both on the eighteenth, and again lost both on the twentieth day. The lesions disclosed did not account for these anomalous conditions. The first mentioned of these cases was that of a gunshot laceration of both cerebellar lobes with cortical hemorrhage at the vertex and in both posterior basal fossæ; the notes of necropsy of the second were confined to fracture; the temperatures, however, had indicated a general cerebral contusion; the third case showed marked cerebral hyperæmia and œdema with lacerations of the right frontal and temporal lobes, and a considerable cloudy subarachnoid serous effusion, and no hemorrhages. In the fourth and last exceptional case, which was of long duration, vesical control was maintained throughout. Rectal control was occasionally lost in the early part of the second month, but toward its end was again perfect. At the end of a year it was habitually lost for about three, and in the fifteenth month for about two days out of seven. The patient died soon afterward. His mind until near the close of the year was active; he was coherent, capable of initiative, and suffered only from delusions which for a long time were confined to locality,—later, mental decadence was general and progressive. He was found at necropsy to have suffered general cerebral sclerosis and marked left frontal atrophy as has been noted in another connection.

The loss of rectal control alone with later necropsy occurred in the first as it did in the second series of cases in three instances only, but in one of them not till final unconsciousness on the seventeenth, and last day of life. In one of the two remaining cases it was confined to a period of primary unconsciousness, and in the other it was secondary, and the mental condition was one of stupor; in both there was found a temporal laceration and extensive cortical hemorrhage.

In each series there was a very limited number of cases in which primary rectal was followed by considerably later vesical loss; and a further limited number of cases in which with primary vesical a later rectal loss followed before both occurred together. A case from the second series will be cited later as illustrative of the conditions last mentioned.

The number of fatal cases without necropsy, as well as of those which recovered, in which loss of rectal control occurred independently of vesical loss, was as limited as that of those with vesical loss already considered. The whole number in all cases of both series (1000 cases), in which with rectal loss vesical control was at the same time primarily and permanently retained was but fourteen, and the number in which independent rectal loss followed primary vesical loss, or alternated with it, was still less. The attendant conditions as regarded states of consciousness and mental competency were the same in both fatal and recovering cases. The paralysis and diminished reflexes observed in one instance cited were not noted in either of the others examined. Coincident retention of urine with necessary catheterization occurred in a noteworthy proportion of cases.

In fatal cases in which both vesical and rectal, or vesical control alone, was lost and in which post-mortem examination was not practicable, attendant conditions were naturally similar to those already noted where such opportunity was afforded. In 50 per cent. of these, primary control was retained with more or less complete unconsciousness, delirium, or rational intelligence. Cases of rectal or vesical default, occurred from the second to the forty-second day. When control was long maintained the patient was in some instances in stupor but fully conscious and intelligent at time of final loss.

In recovering cases these losses were in much smaller proportion. The loss when it occurred was much oftener primary than secondary, without regard to mental condition, and as in the fatal cases was usually vesical when only a single function was involved. The loss if secondary usually occurred on the second or third day. In one instance, however, control was retained till the thirteenth day, when vesical control was lost. The patient, previously delirious, was then rational though apathetic.

Loss of control as it has been considered has referred exclusively to unconscious or involuntary discharges from the bladder or rectum. In a very much smaller number of cases there was an abnormal retention of urine which required catheterization. The whole number of cases in both series was 53, scarcely more than 5 per cent. of the total of 1000. Twenty-eight were fatal and in 17 of these the use of the catheter was required on the first day as it was in 16 of the 25 recoveries. In the others retention occurred from the second to the eleventh day. The pupils were in most instances abnormal, and much oftener dilated than contracted. Coincident fecal discharges, with or without control, occurred in a number of instances, and when life continued for some length of time, especially if the ending were fatal, rectal or vesical discharges occurred secondarily without volition. The mental states, and the lesions when disclosed, were as varied, as were those in cases previously examined in which discharges were without normal restraint.

It appears from this review of both fatal and recovering cases that rectal and vesical control is lost or retained under all mental conditions and following all recognizable forms of cerebral injury. The same patient may lose and regain, or retain and subsequently lose control during a continuance of the same mental state. It is equally independent of muscular power or of general reflex conditions.

As in many cases the patient is unconscious, or actively delirious, the loss of control might be supposed to depend in them upon deficient perception or deficient will power, as it may do under the same conditions in cases apart from intracranial traumatism. This explanation, however, does not serve to account for the default in the large number of cases of mild delirium, delusional mental disorder or moderate degrees of stupor; and still less for the considerable number of others in which entire consciousness and rational intelligence are maintained.

It is impossible to find an explanation for the rectal or vesical defect in the character or site of intracranial lesions. They have been found to be both limited and diffuse, nearly always multiple, and to affect all cerebral and meningeal regions. In a study of the first series of cases it was ascribed to cerebral laceration; and a consideration of those cases probably seemed to justify a conclusion. The post-mortem findings in the present larger number of cases fail to confirm its correctness. Laceration, in fact, existed in somewhat less than half of the number comprised in the combined series, and in many was complicated by hemorrhage, and in all by some farther manifestation of a wider cerebral injury. In a large percentage of cases it involved the left frontal lobe, but not sufficiently often to warrant an association of the rectal or vesical default with the usual mental defects dependent upon lesion of that region. In view of the universality of the general lesion, and in the absence of a constant or even characteristic limited brain injury, it is evident that the sphincters have no special centres of even contributive control corresponding to those which have been demonstrated for other muscles.

In a "Contribution to the Pathology of the Sphincters" (ANNALS OF SURGERY, 1901, vol. xxiv, Corner), the writer after observing 100 cases of head injuries, and remarking that figures are valueless concludes that "the figures themselves show that the main cause (of affection of the sphincters) is the amount of violence; as in concussion of the brain the affection of the sphincters is infrequent, whilst in fractures of the skull, etc., they become more frequently affected." To this statement it may be excepted: first, that the amount of violence inflicted upon the cranial contents is not to be measured by the occurrence of fracture, or its absence; and second, that the dependence of affections of the sphincter upon the amount of violence inflicted can only be determined by the figures which he contemns. As a matter of fact intracranial injuries are no less severe when the cranium is intact; and a reference to the records of the cases cited in this paper shows that in them in proportion to their number affections of the sphincter are no more frequent with fracture than without. It has been further shown that in the 1000 cases 217, or nearly one-fourth, were without fracture, while loss of control in them occurred in a ratio of one to three as compared with those in which fracture was an incident. If it be true that affections of the sphincters are frequent in proportion to the amount of violence inflicted, *ceteris paribus,* it is no less true of other symptoms of importance.

The same author arrives at certain other conclusions which are equally at variance with those deducible from observations made in the present series of cases. His classification is simple and seemingly independent of pathology. "Concussion is a condition in which the symptoms are most severe at the time of the receipt of the injury, and then progress favorably;" while in compression "they get progressively more severe if allowed to take their course"; and "fractures of the skull present in their general symptoms the signs of concussion, compression being excluded, and the diagnosis of contusion or laceration of the brain uncertain." It is of course impossible to follow his study of disordered action of the sphincters with such a classification of cases if we accept a present pathology in which concussion disappears, compression apart from contusions becomes most infrequent, and cranial fracture has few general symptoms of importance, except through its complications which are identical with those conditions which equally occur in its absence. His first subdivision would include all cases of recovery, urinary retention occurring in nearly 23 per cent. as against less than 5 per cent. in all classes of recovering cases in the present series. His cases of compression would probably be identical with those in which are found the lesions of contusion; in these he states, "active retention will rather probably have occurred during preliminary concussion which passes on to the passive retention of paralysis, and when the symptoms of compression are marked paralytic overflow takes place."

This has not been the history of the cases upon which the present paper has been based.

Finally: 8 out of his 13 cases of cranial fracture, nearly two-thirds of their number, "showed affection of the sphincters, all of which were active retentions, 4 being allowed to proceed to incontinence."

This percentage differs widely from that noted in the cases which have been cited here. Urinary retention occurred in only 39 out of 783 cases, none of which were permitted "to pass on to the passive retention of paralysis."

Normal urination is an automatic reflex action wholly dependent upon the sympathetic system. The habitual intervention of consciousness and volition is not essential to the proper performance of the function. The expulsive force of the detrusor muscle is excited exclusively through the ganglia of that system, and the restraining power of the vesical sphincter is so far controlled by them that even in health the influence of the cerebral centres may be suspended when excitation has reached a certain degree of intensity. The interposition of consciousness and volition while not essential to the voidance of urine is nevertheless requisite to the well-being of the individual, and when prevented is indicative of functional or structural disease. The cases of intracranial traumatism which have been cited show not only that the methodical expulsion of the rectal or vesical contents may continue for a length of time when both consciousness and volition are wanting, but that with full consciousness and with volition otherwise unimpaired these discharges may be involuntary.

It is evident from this view of the facts connected with uncontrolled action of the sphincters in cases of intracranial injuries:—

That it is a true symptom and not a mere accident of suspended consciousness or mental impairment.

That while of no service in prognosis, or as an indication for treatment, it has much diagnostic importance.

That it is characteristic of intracranial injury, and at the same time independent of the nature or site of lesion.

That it must therefore be an indirect rather than a direct symptom.

That its origin is to be found in some interruption of a harmony of function between the cerebral and sympathetic nervous systems which is a result of direct injury of any part of the brain or its membranes.

That it is thus etiologically allied to asymmetrical arterial pulsations and to pupillary disturbances.

The dependence of abnormal circulatory and pupillary conditions upon a secondary implication of the sympathetic system is even more directly obvious than is that of the uncontrolled action of the sphincters. The exclusive control of the vascular system by the sympathetic must necessarily involve its immediate responsibility for abnormal no less than for normal conditions. The channels through which the influence of the intracranial lesion is exerted is less certain, but it seems probable that it is through the sympathetic filaments which are everywhere distributed upon the cerebral vessels.

The direct connection between the intracranial injury and the abnormal condition of the pupil is more nearly demonstrable. As was long since determined the reflex movements of the iris, though made through the medium of the ophthalmic ganglion, derive their original stimulus through the motor oculi communis nerve. Hutchinson observed the dilatation of the corresponding pupil from direct intracranial pressure of extravasated blood upon that nerve in its passage through the middle fossa. It is conceivable that any other intracranial lesion may more indirectly reach the ophthalmic ganglion through the same channel and produce the same pupillary effect.

It will be unnecessary to cite many cases to illustrate the lack of rectal vesical control when no longer subjected to the will. Case XL (see Temperature) is further illustrative of the purely automatic character of the reflex action of the vesical sphincter in cases of intracranial injury; and in this connection three cases may be quoted in which the distinctly automatic action of the rectal and vesical sphincters is clearly demonstrable.

CASE LVIII.—*Automatic Action of Both Rectal and Vesical Sphincters. Recovery.*—The patient was admitted to another hospital in an unconscious condition following a suicidal pistol-shot wound in the right temporal region. The positive symptoms were: drowsiness; stupidity and slowness of speech; lack of vesical and later of rectal control; ptosis; and slight dilatation of the left pupil. Temperature rose to 101°. One week later an epidural clot about the size of an English walnut was removed from the left posterior frontal region. Temperature became normal and there was gradual mental improvement. Rectal and vesical control remained in default.

He was admitted to Bellevue Hospital on the thirty-fifth day. His symptoms then were: slight headache; a nervous and restless manner, with at intervals a vacant look; exaggerated reflexes; a distinct ankle clonus; and a lack of rectal and vesical control with full consciousness of natural desire. Ten days later control of both functions was regained.

In a similar case with recovery, after the disappearance of all other symptoms, rectal and vesical discharges were still involuntary although the patient in each instance was conscious of the impending event.

Case LIX.—*Loss of Both Rectal and Vesical Control. Recovery.*—Patient unconscious and vesical control lost on admission to the hospital. On the third day his mental condition was practically normal and vesical control was regained; on the fourth day he was delirious; and on the fifth day had delusions; on both days vesical control was again lacking; on the seventh day he was rational and intelligent but still without vesical control, and with rectal control variably lost or retained; on the ninth day he was mildly delirious and both rectal and vesical control was lacking; and on the tenth and eleventh days though his mental condition was entirely normal, both rectal and vesical control was still lost.

Case LX.—*Primary Vesical, and Secondary Rectal, Loss of Control, with Still Later Loss of Both Together. Necropsy.*—Patient unconscious when admitted to the hospital and vesical control lost.

Second day: patient conscious and rational; incomplete left hemiplegia; continued loss of vesical control.

Third day: vesical control regained; no other change.

Fourth day: patient delirious; muscular power on left side regained; general convulsions; vesical control again lost.

Fifth and sixth days: mental condition normal except for occasional delusions; vesical control regained; rectal control lost.

Seventh and eighth days: mental condition normal; vesical control lacking; rectal control variable.

Ninth day: mild delusions; left arm rigid; deep reflexes diminished; rectal and vesical control both lacking.

Eleventh day: patient rational; patellar reflexes present; no rectal or vesical control; and neither subsequently regained.

Necropsy.—Excessive general meningeal hyperæmia; limited areas of meningeal contusion with corresponding serous and hemorrhagic effusions; subcortical excavation of both frontal lobes.

VII.—MINOR SYMPTOMS.—There are certain other general symptoms of minor importance and not peculiar to head injuries. Two of these only are of frequent occurrence.

Vomiting is perhaps the most frequent, and has certainly been accorded the most consideration. Hæmatemesis, the ejection from the stomach of blood swallowed in succession to hemorrhage into the mouth or nares, should be excluded as being a gastric symptom, merely mechanical and only indirectly connected with the cranial or intracranial injury. With this proper limitation vomiting occurred in about 13 per cent. (132) of the total number of cases, usually very soon after admission to the hospital or even earlier, but occasionally delayed for a number of hours. It sometimes occurred but once, and sometimes continued even till the following day. The matter vomited was most frequently undigested food, occasionally with a little admixture of blood which in other cases gave a brownish tinge to a mixture of bile and gastric fluids. It was profuse or scanty according to the amount of food the stomach happened to contain. It was not often associated with symptoms of general shock, nor in a majority of cases with a subnormal temperature. It occurred in a rather larger percentage of cases with the much smaller number of children injured than with adults. In short, it had no special characteristics which distinguished it from vomiting under any other circumstances. Its chief importance seems to reside in the fact that it has been counted among the diagnostic symptoms of so-called concussion. It is unnecessary to confront this symptom in detail with the lesions with which it has been found to be associated. In the twenty cases in which opportunity was afforded for post-mortem inspection the lesions in each instance were markedly severe, and as in case of asymmetrical pulse, abnormal pupil and loss of sphincteric control, it represented all forms of intracranial hemorrhage and contusion, and involved all intracranial regions. There is no reason to doubt that like them it is a result of disturbance of the sympathetic system of nerves. It is associated with no special intracranial injury, has no distinctive characteristics, and is entirely independent of volition. It differs in no respect from vomiting induced by any other form of sudden injury, or by mental shock or violent emotion.

The occurrence of chill or of a profuse perspiration is too infrequent, and of too little apparent significance to justify more than brief remark. Two cases in which there had been a chill were subjects of necropsy. Symptoms had been diverse, but in each cerebral œdema and hyperæmia were excessive, with a large pial hemorrhage in one and a large epidural hemorhage in the other. As similar conditions are habitually observed without the chill, there is no reason to suppose a special relation to exist between them in these very exceptional instances.

Chill, like vomiting, is not an unusual indication of any severe shock mental or physical, sustained by persons of susceptible nervous organization. Perspiration more or less profuse, occurring in rare instances as a primary or later symptom, has no greater significance. It is a simple trophic disturbance with which the cerebral nervous system can have no more intimate connection than when it occurs under other and more ordinary circumstances.

Headache and vertigo belong to another category of symptoms. They are the result of the meningeal or cerebral circulatory derangement, and in nowise differ in character from the same symptoms as they attend similar derangements following indigestion, a febrile action, or other morbid state. As circulatory conditions are always altered in case of intracranial injury, headache is naturally one of its frequent indications, and usually denotes hyperæmia. Vertigo is less frequent and is oftener the result of anæmia. Headache has no further significance. It may be early or late, intense or moderate in degree, general or localized; but aside from certain cases of cranial fracture does not point to the site, severity, or nature of the lesion.

Vertigo as a focal symptom from injury of the eighth nerve will be found in a number of the cases of fractured base with hemorrhage from the ear.

VIII.—Muscular Disorders.—The muscular disorders were both local and general. Their character, and comparative frequency in fatal and recovering cases are shown in their classification:

Convulsions:

Fatal cases	75
Recovering cases	35
	110
Necropsies	50

Convulsive Movements and Minor Muscular Contractions:

Fatal cases	56
Recovering cases	24
	80
Necropsies	44

Muscular Rigidity:

Fatal cases	101
Recovering cases	29
	130
Necropsies	71

PARALYSIS.

General:

Fatal cases	6
Recovering cases	2
	8
Necropsies	6

Paraplegia:	
Fatal cases	1
Recovering cases	2
	3
Necropsies	1
Hemiplegia:	
Fatal cases	44
Recovering cases	24
	68
Necropsies	27
Upper Extremity:	
Fatal cases	10
Recovering cases	14
	24
Necropsies	6
Lower Extremity:	
Fatal cases	2
Recovering cases	0
	2
Necropsies	2
Face:	
Fatal cases	30
Recovering cases	31
	61
Necropsies	18
Ocular Muscles (Approximately)	50

The actual percentage of cases characterized by derangements of muscular action is somewhat less than that indicated in these tables, since in at least one hundred, two or more co-existed in the same individual.

Convulsions, Convulsive Movements, and Muscular Rigidity.—When the present series of 1000 cases was examined in blocks of 100 some remarkable variations were observed in the comparative frequency with which convulsions had occurred. The average number of cases was 10 and a fraction for each 100; but while in the fourth hundred there were 19, in the eighth there were only 3, and in the ninth again there were 12. This is important only as showing the absolute necessity of statistics being compiled upon a large scale if they are to be of value. Similar discrepancies have been often noted in the comparison of other conditions when they have been studied in the same numerical subdivisions.

The conditions which may predispose to convulsive attacks in cases of intracranial injury do not seem to be largely operative. The most important is sex. Nine only of the 110 cases observed were of females, and the importance of a large aggregate of cases for statistical deduction is again evident in the fact that but one of these occurred in the last 500 cases. Three of the 9 were young children, and 3 were suffering from alcoholic excess.

The relation of age to frequency, and to prognosis, may be best shown in tabular form.

	Cases.	Recovered.	Died.
From 2 months to 8 years	19	6	13
From 10 to 20 years	13	5	8
From 20 to 30 years	23	12	11
From 30 to 40 years	19	4	15
From 40 to 50 years	14	3	11
From 50 to 60 years	16	1	15
At 70 years	1	1	0
	105	32	73
Adults—age not specified	5		
	110		

The 19 cases in infants and young children were all that occurred in a total of 102 instances of intracranial injury in children, three-fourths of whom were less than 7, and none more than 10 years of age. Simple convulsive movements occurred with about the same frequency. It is apparent from these figures that early childhood, not less than womanhood resists, rather than predisposes to, convulsive attacks—contrary to what might have been anticipated from their greater susceptibility of nervous organization.

The rate of mortality was high at all ages, and in children was 70 per cent. as against 21 per cent. with intracranial injuries when this complication did not exist.

Five cases at least were those of epileptic patients who had received their injury from falling while in a paroxysm; and others who were known epileptics. Two had suffered from epileptiform attacks resulting from previous traumatism.

Several of these patients were admitted to the hospital in an intoxicated condition, and many doubtless were habitual inebriates; but as at least an equal proportion of those who had no convulsions had a similar record there is no reason to suppose that the alcoholic habit or condition was influential in producing the paroxysms. It seems probable that aside from sex there is no predisposing circumstance greatly affecting the operation of the direct cause resident in the intracranial lesion. The reason for the comparative exemption of women is not apparent.

Post-mortem examination discovers no focal lesion which can be held responsible for these violent muscular disturbances. Even when unilateral the attendant lesions disclosed are multiple; and so far as they are limited may equally appear upon the same or upon the opposite side of the brain. There is, however, a demonstrable relation between the lesions and the convulsive disorder. In almost every instance both the cerebral cortex, or its meninges and the subcortex are involved. Dural wound or inflammation, pial contusion indicated by thickening, adhesion, infiltration or subarachnoid effusion, acute or subacute arachnitis; cerebral contusion or laceration with cortical hemorrhage; one or more were present in every case save one; and in that an enormous epidural hemorrhage closely compressed the cerebrum and its membranes upon the inner cranial surface. In 10 cases there was no laceration involving the subcortex; but in each there was other deep seated lesion of importance—either excessive hyperæmia and œdema, or sclerosis. In a possible exceptional case an acute arachnitis was alone noted. The lacerations in all but 5 cases involved the temporal or frontal lobes or the optic thalamus; 3 were limited to the anterior parietal, and 2 to the occipital region. It was also the anterior parietal region which was lacerated in the few cases in which the parietal was involved with the temporal or frontal lobe.

It may be assumed therefore with considerable confidence, though not with certainty, that when convulsions occur there are both superficial and deep intracranial lesions and that the limited lesion is confined to the anterior region of the brain or involves an optic thalamus.

Simple convulsive movements are so closely allied to typical convulsive paroxysms that no distinctive differences can be supposed to exist in their underlying lesions. In a postmortem examination of 30 cases in which such movements had been uncomplicated by other muscular disorders, it was found that in 50 per cent. there was no laceration, and that in a considerable number of others an epidural hemorrhage as the most important superficial lesion replaced the subdural pathological conditions noted when paroxysms had been complete. In general the lesions had been no less severe or complicated.

Convulsions were usually epileptiform in character, and when epileptic were probably in subjects of previous epileptic habit. They were unilateral in 10 cases, were confined to the face and upper extremities in 2, and were general in the remaining 98. They were primary in 67, and secondary in 43; they occurred as a single attack, or when multiple recurred in rapid succession or after an interval of many days. They were variously preceded, accompanied, or succeeded by muscular rigidity, paralysis or other symptoms of intracranial injury, as might be expected from the multiplicity of attendant lesions.

Convulsive movements were observed under all possible conditions. They occurred in all regions of the body including the face and extremities, involving all the muscles of a part or limited to groups or even to individual muscles. It is impossible to ascribe to them definite relations to other general symptoms by which they were accompanied.

Muscular rigidity, like simple clonic muscular contractions, occurred either by itself or as an accompaniment or precursor of other abnormal muscular conditions. Like the clonic contractions it was general or limited, early or late in its manifestation, transient or permanent, and of a greater or lesser degree of intensity. Unlike the localized clonic contractions, which often terminated in a general convulsion, it did not tend to a general tonic spasm.

A general pial or cortical hemorrhage or subarachnoid serous effusion in many cases attended general rigidity or convulsive movements; and less often a local lesion corresponded to a limited muscular disturbance; but the exceptions to such a correspondence were too numerous to permit its acceptance as a general rule. The following instances will serve as illustrations:

1. *Cervical Rigidity*—noted on third day.

Lesions: Epidural and pial hemorrhages in right middle basal fossa; subarachnoid effusion confined to vertex; general cerebral hyperæmia and œdema.

2. *Cervical, Followed by General, Rigidity.*—Cervical rigidity on the fourth, with rigidity of upper and lower extremities on the fourteenth, and increased cervical rigidity on the twenty-first day.

Lesions: Laceration of the inferior surface of left frontal lobe with large cortical hemorrhage in anterior and middle basal fossæ; moderate subarachnoid effusion at vertex; none at base.

3. *General Rigidity.*—Primary general convulsive movements followed by a general spastic condition of the muscles.

Lesions: Limited cortical laceration and contusion of right temporal lobe, with cortical hemorrhage in all the right basal fossæ.

4. *General Rigidity.*—Primary; more marked on right side.

Lesions: Small epidural hemorrhage over left frontotemporal junction; laceration of first and second left temporal convolutions with cortical hemorrhage limited to the temporal (lobe) region.

5. *Rigidity of Right Arm and Leg.*—Primary.

Lesions: Epidural hemorrhage over left, and pial hemorrhage over right temporal lobe; contusion of all the right temporal convolutions; small amount of serum in each lateral ventricle.

6. *Rigidity of Left Arm and Leg.*—Primary; later the left extremities became restless; the right extremities remained motionless.

Lesions: Subacute arachnitis confined to posterior parietal and occipital regions; slight pial hemorrhage upon left inferior cerebellar surface; limited contusion of fornix posteriorly; excessive general hyperæmia and œdema.

7. *General Rigidity:* Manifested on eighth day; most pronounced in right upper extremity.

Lesions: Decolorized thrombi in both lateral and both inferior petrosal sinuses; entire brain, including cerebellum and basal ganglia, hyperæmic with moderate œdema.

8. *General Convulsive Movements:* at end of first day.

Lesions: Moderate subacute meningitis with serous effusion limited to right parietal region; purulent effusion at base; limited cortical contusion of left temporal lobe; excessive cerebral hyperæmia and œdema.

9. *General Convulsive Movements.*—Primary; gunshot wound.

Lesions: Ball passed through right hemisphere anteroposteriorly on a plane slightly above the corpus callosum.

10. *General Convulsive Movements.*—Primary and strongly marked, involving various sets of muscles.

Lesions: Epidural hemorrhage from rupture of left sigmoid sinus; pial hemorrhage over left parietal lobe; cortical contusion of left temporal lobe.

11. *Convulsive Movements of Right Side and Rigidity of Left Side.*—Both conditions primary and strongly marked.

Lesions: Epidural hemorrhage covered whole lateral surface of right hemisphere and to within one inch of median fissure. Cortical hyperæmia; slight contusion of second left temporal convolution.

12. *Convulsive Movements of Both Arms.*—Primary.

Lesions: Cortical hemorrhage over inferior surface of both frontal lobes, and over superior surface of cerebellum; laceration of inferior surface of left frontal lobe; subcortical contusion of anterior portion of right optic thalamus with punctate extravasations and of pons in transverse fibres; moderate cerebral hyperæmia and œdema.

13. *Single General Convulsion:* Preceded by left hemiplegia, and accompanied by rigidity of left upper extremity on the fourth day.

Lesions: Four areas of meningeal contusion; one over each frontal lobe and one over each parieto-occipital junction; each about two inches in diameter with subarachnoid serous and hemorrhagic effusion; small contusion of right temporal lobe; subcortical excavation of both frontal lobes extending into right motor area.

14. *Multiple General Convulsions.*—Seven convulsions on the second day, preceded on the first by convulsive movements.

Lesions: Extensive laceration of left temporal lobe, and cortical hemorrhage in middle and anterior basal fossæ; blood in great part had escaped through cranial fissures into tissues about the eye.

15. *Unilateral Multiple Convulsions.*—Primary; began in face; tonic preceded clonic contractions.

Lesions: Direct laceration of dura and pia mater and lateral surface of right temporal lobe at point of fracture; cortical hemorrhage in right middle and posterior basal fossæ.

It is evident from these illustrations, which might be very greatly extended, that while a meningeal or cortical lesion almost invariably exists, and is usually associated with one more deeply seated, both tonic and clonic muscular contractions are independent of the exact site or nature of lesion. The occasional instances in which the motor zone is directly affected by gross injury or pressure are but accidental; and even when this area is involved it is usually by a hemorrhage or subarachnoid effusion insufficient in amount to be of much apparent importance in explaining the muscular disturbances as of focal origin. The extreme frequency of lesion of a temporal lobe is worthy of note.

Paralysis.—Traumatic differ from idiopathic paralyses only in their origin and in the nature of their lesions. General paralysis and paraplegia, however, are so infrequent in the course of intracranial injuries as to justify some special reference to the history of such as are included in the present series of cases.

General Paralysis.—One of the eight cases noted evidently resulted from a coincident injury of the spinal cord, and the patient was discharged from the hospital on the twenty-second day with incomplete recovery. In a second case the patient survived under observation for six months. He had jumped from a ship's deck to a raft alongside, a distance of twenty-five feet, and was at once admitted to the hospital with left hemiplegia and paresis of the right upper extremity. He was later generally hyperæsthetic with the exception of the left leg which was anæsthetic. The still later symptoms included those referable to lesion of the left prefrontal region which continued, together with the loss of power in the paralyzed leg, at the time of his discharge from the hospital.

The six cases remaining were all fatal, and the relation of muscular conditions to lesions were as follows:

Case LXI.—Manner of injury unknown; patient unconscious; left pupil dilated and both pupils without reaction; respiration shallow; total paralysis.

Lesions.—Fracture extending from torcular herophili to foramen magnum; pial hemorrhage filling both posterior and basal fossæ; general cerebral contusion with œdema and much serous effusion in both lateral ventricles. Died in ambulance.

Case LXII.—Patient fell fifteen feet, striking her head upon the pavement; unconscious; primary right hemiplegia, and paresis of left side and right face; both patellar reflexes lost; respiration ceased abruptly; cardiac pulsations continued for an appreciable interval. Died in twenty-four hours.

Lesions.—Fissure extended from left inferior parietal region through petrous portion into middle basal fossa; large subcortical excavation of left temporal lobe; blood breaking through the cortex at one point from which a thick clot extended over the anterior part of the lobe and in a thin sheet covered the whole left frontal and parietal lobes and anterior part of left occipital lobe. Blood had also flowed from the left temporal region through the Sylvian and median fissures and formed a thick clot over the pons and medulla; moderate cerebral hyperæmia and œdema.

Case LXIII.—Patient fell down one flight of stairs; coma; pupils dilated and irresponsive. Paralysis general. Died in eight hours.

Lesions.—Fracture extending from right occipital inferior curved line across petrous portion, and into sella turica; laceration of inferior surface of right temporal and frontal lobes; cortical hemorrhage filling right anterior and middle basal fossæ, and extending in a thick clot over frontal lobe and into median fissure; large pial hemorrhage covering superior surface of both hemispheres; hyperæmia and punctate extravasations throughout the brain.

Case LXIV.—Patient struck upon the head with a club; a little later sudden loss of consciousness with general slight convulsive movements which soon ceased, but recurred two hours afterward; immediately followed by general paralysis, including both sides of the face with divergent strabismus. Died in twelve hours.

Lesions.—Fine fissure extending from mid-frontal region into left middle basal fossa; pial hemorrhage thickly covering left hemisphere and forming a thin sheet upon inferior surface of cerebellum; no lacerations; minute contusions of right temporal, and inner border of left temporal lobe and of first orbital convolution; moderate hyperæmia and excessive œdema of all parts of the brain.

Case LXV.—History unknown; coma; respiration at times irregular; paralysis of both upper, and paresis of both lower extremities; general impairment of sensation; slight movement of fingers and of right wrist; patellar reflexes absent. Died on third day.

Lesions.—Fracture extending from right temporal bone into foramen magnum; epidural hemorrhage in a thick clot flattened right vertex and extended to base; no lacerations; general cerebral hyperæmia and œdema.

Case LXVI.—Patient jumped from the third tier of the Tombs prison to the flagging below; various signs of intracranial injury but no muscular disorders until the sixth day when all the extremities became paretic, most markedly on the right side, with impaired sensation; some right facial paralysis two days later; general paralysis continued until death on the sixteenth day.

Lesions.—Fracture extending from left squamous portion of temporal bone along anterior surface of petrous portion into optic foramen; slight lacerations of right temporal lobe with cortical hemorrhage extending from occipital lobe forward and barely reaching to motor area; intense cerebral hyperæmia; excessive cerebral œdema, serum following the knife on section; ventricles distended.

The first and second of these cases are readily explicable by a possible flow of blood from the posterior basal fossæ into the spinal canal, and the third by a compression of both motor areæ by a pial hemorrhage. The other three are less readily comprehensible. One motor area only was compressed in the fourth and fifth cases; and in the sixth, as well as in the fourth and fifth, cerebral œdema was excessive.

Paraplegia.—The instances of paraplegia were but three in number, and the only one which was fatal afforded upon necropsy no positive results. Death occurred five minutes after admission to the hospital. The lesions were: Fracture extending from left posterior parietal region into the anterior and middle basal fossæ; epidural hemorrhage, still fluid, extent not noted; slight hemorrhagic extravasations into the meshes of the pia mater; and slight lacerations of the inferior surface of the left temporal and frontal lobes.

The cases of recovery were:

CASE LXVII.—Trifling scalp wound in left mid-parietal region near the median line with a large hæmatoma, variously accounted for by the patient who was sure he had been struck, but was uncertain whether by a railroad bridge, or by a bootblack; complete paraplegia the only general symptom; reflexes slightly exaggerated; muscles flaccid; no previous paralysis; no history of syphilis; treated with potassium iodide. He was able to walk fairly well after one week.

CASE LXVIII.—Patient six years of age had been struck by a box falling from a distance; unconscious; compound fracture of vertex with epidural hemorrhage; paraplegia on the fifth day. Sensation unimpaired; reflexes normal; highest temperature 100.2°; he could walk a little with support on the forty-fifth day.

Paralysis of One Lower Extremity.—Necropsy was had in both the two cases noted. In one of these, patches of lymph were deposited over both margins of the median fissure, and may perhaps afford adequate explanation of the paralysis which occurred on the fifteenth day after injury; in the other case, one in which there was paralysis of the left lower extremity, the lesions were: Fracture extending from the left squamous portion through the left middle and both anterior basal fossæ; a large epidural clot in the left middle fossa, and a general cerebral contusion.

Paralysis of the Upper Extremities.—While the instances of a paralysis confined to one or both the upper extremities were more frequent than paralysis of a single lower extremity, their percentage was still small. They were 24 in all, of which 10 were fatal and 6 were subjected to a post-mortem examination. They were primary or secondary in equal number, and were oftener incomplete than complete. They were of both transient and permanent duration and were variously complicated or uncomplicated by disorders or losses of sensation.

The lesions noted at necropsy were:

1. Primary paralysis and anæsthesia of the left upper extremity—preceded by convulsive movements for five minutes.

Epidural and cortical hemorrhage over whole left hemisphere; cortical hemorrhage over right motor area; marked cerebral hyperæmia; extensive lacerations of right frontal and temporal lobes.

2. Paralysis of right upper extremity on the fourth day.

Epidural clot compressing and flattening the whole left hemisphere; laceration of the left temporal lobe; lateral ventricles distended with serum, each to the amount of two ounces; and *iter e tertio ad quartum ventriculum* distended to size of goose quill; small hemorrhage in floor of fourth ventricle.

3. Paralysis of left upper extremity on the second day.

Large cortical hemorrhage over right temporal lobe, and in thick clot over upper part of fissure of Rolando; general cerebral hyperæmia with minute thromboses; thrombus in lateral sinus.

4. Primary paralysis of right upper extremity preceded by anæsthesia; both disappeared within twenty-four hours.

Moderate subarachnoid effusion; subcortical excavation of whole left frontal lobe with blood breaking into the lateral ventricle; subcortical excavation of right frontal lobe with blood breaking through the cortex; deep laceration of posterior border of the cerebellum, brain hyperæmic and œdematous; minute vessels filled with coagula.

5. Paralysis of right upper extremity on second day, with rigidity of both arms and right leg.

Epidural clot compressing left hemisphere and extending from Sylvian to median fissure; entire brain excessively hyperæmic.

6. Paralysis of right upper extremity on the ninth day preceded by general muscular rigidity and convulsions, and accompanied by slight right facial paresis.

Large arachnoid serous effusion; thin pial hemorrhage covering both parietal and both occipital lobes; small lacerations of right frontal and left occipital lobes; general cerebral hyperæmia and œdema, with minute thromboses, punctate extravasations, and serous fluid in left lateral ventricle.

In each instance but one, and possibly in that one the motor area of the opposite side was covered by blood or a serous effusion; but the amount of pressure exerted, or its sufficiency as the cause of the paralysis is uncertain.

Hemiplegia.—Cases of hemiplegia were usually complicated by other muscular disorders. These were:

	In fatal cases	In recovering cases
Convulsions	7	4
Facial paralysis	10	8
Convulsive movements	10	3
Muscular rigidity	8	5
No muscular complications	9	4
	44	24

The accessory muscular disorders were general, or were limited to either the hemiplegic or opposite side, and were in varying degrees prominent in the history of the case.

The hemiplegia which, as in idiopathic cases, might be either suddenly or progressively developed and might be either a complete or an incomplete loss of muscular power, was primary in 27 fatal, and in 12 recovering cases; and was secondary in 17 of those which were fatal and in 12 of those which recovered.

Anæsthesia was concurrent in 7 fatal and in 2 recovering cases.

Destruction of the optic thalamus was undoubtedly responsible for the occurrence of hemiplegia in 2 cases, and compression of the motor area by blood or inflammatory exudation seems adequate explanation in 10 others of the 27 in which post-mortem examination was made. In 6 of the cases remaining a similar compression was possible; in 3 the notes of necropsy were deficient; and in 6 no gross lesions of the motor area or motor tract existed.

The lesions in the cases last mentioned were:

1. Right primary hemiplegia. Laceration of external border of right cerebellar lobe with cortical hemorrhage about the circle of Willis, upon the anterior portion of the pons and in the transverse fissure; hemorrhage (apoplectic) in the left lateral ventricle, breaking into the right ventricle and into the left occipital lobe which it completely excavated.

2. Left secondary hemiplegia. Subarachnoid serous effusion limited to frontal regions; excessive cerebral hyperæmia with minute thromboses.

3. Left secondary hemiplegia. Excessive meningeal and cerebral hyperæmia with minute thromboses.

4. Left primary hemiplegia. Cortical hemorrhage over left hemisphere from laceration in posterior parietal region.

5. Left primary hemiplegia. Pial hemorrhage in posterior basal fossæ and in right lateral ventricle.

6. Left primary hemiplegia. Pial hemorrhage over left hemisphere; subcortical laceration of right posterior inferior portion of parietal lobe, and of first and second right temporal convolutions, from which blood had escaped into the right ventricle.

Facial Paralysis.—Facial paralysis was somewhat less frequently complicated by other muscular disorders than hemiplegia; but was equally varied in its manifestations. It was fatal or recovering, and was primary or secondary in nearly equal proportions. It was variably general, or confined to either the upper or lower face area, was transient or permanent, was slight or complete, and was as devoid of special peculiarities as are all other forms of traumatic paralysis. It was associated with general paralysis in 1 case, with general convulsions in 11, with hemiplegia in 11, and with paralysis of an upper extremity in 7 cases. It was double in only 2 instances, and was not often accompanied by simple convulsive movements.

Necropsy was had in 18 of the 30 fatalities, but in 2 the notes are missing. In 6 of the remaining 16 cases there were other paralyses in connection with which they have been given consideration. In 3 of the final 10 cases in which paralysis was facial alone there were no gross lesions of the face centre, motor tract, or facial nerve.

The lesions noted in these cases were:

1. Incomplete right facial paralysis. Epidural hemorrhage in right midfrontal region in an area of about 2 x ¾ inches; cortical laceration of inferior surface of both prefrontal lobes and of left temporal lobe; marked general hyperæmia, especially of the cortex, and moderate œdema.

2. Right facial paralysis. Epidural hemorrhage in right parietal and occipital regions; cortical hemorrhage in both superior occipital regions; both hemorrhages in moderate amount; laceration of inferior surface of both frontal lobes anteriorly; brain excessively hyperæmic and œdematous.

3. Right lower facial paralysis, manifested on the sixth day. Small epidural hemorrhage limited to left prefrontal region; laceration of inferior surface of both frontal lobes, mainly subcortical; general cerebral hyperæmia, with minute thrombosis, especially in the occipital region.

The frequency of injuries of the temporal lobe is as noticeable in case of the various paralyses as it was in case of muscular rigidity and convulsive movements already mentioned. In the several instances of serious lesions of an optic thalamus it is perhaps probable that the inner capsule was involved.

Disorders of the Ocular Muscles.—These occurred in about equal number in fatal and in recovering cases. They included exophthalmos, convulsive movements, conjugate deviation, general paralysis of the ocular muscles, ptosis and strabismus. They were noted in 15 cases. These were:

1. Four cases of exophthalmos, 3 with fracture through both anterior fossæ and hemorrhage into the orbit, and 1 without fracture, which was slight and unilateral, with ecchymosis of the upper lid and a large hæmatoma in the temporal region of the corresponding side.

2. Two cases of convulsive movements; 1 occurring *in articulo mortis,* following general convulsions, and the other paroxysmal, confined to one eye, and accompanied by convulsive movements of the upper extremity of the same side.

There was nothing to suggest that these differed from those cases marked by similar movements in other limited groups of muscles. The obvious essential lesion in one instance was an epidural hemorrhage, and in the second, a special hyperæmia of one optic thalamus.

3. Six cases of conjugate deviation. The muscular conditions and lesions in these cases were:

a. Eyes turned upward and to the right; on the second day slight convergent strabismus. *Lesions:* Dura mater greatly congested in its posterior two thirds; longitudinal sinus containing white clots in its anterior half, and in its posterior half filled with red coagulum; acute arachnitis with seropurulent effusion at the vertex and thick pus at the base; fracture through middle and posterior basal fossæ.

b. Eyes turned to right and fixed in tonic spasm; later, spasmodic contractions of various groups of muscles. *Lesions:* Large epidural hemorrhage from rupture of the sigmoid sinus; pial hemorrhage over right parietal lobe extending from fissure of Sylvius upward; contusion of third left temporal convolution; linear fracture, 8 inches long, immediately in front of coronal suture, with depressed fragment 1½ inches square, involving both right frontal and right parietal bone; comminuted fracture at left parieto-occipto-squamous junction with fissures extending into middle and posterior fossæ and intervening petrous portion.

c. Eyes turned to right; slight general convulsive movements. *Lesions:* No lacerations or intracranial hemorrhages; moderate subarachnoid serous effusion in right parietal region; purulent effusion in moderate amount over anterior border of the pons, posterior border of the cerebellum, and posterior portion of the inferior cerebellar surface; cortical contusion, 3 x 2½ inches in extent, embracing middle portion of first left temporal convolution and adjacent parietal surface; excessive cerebral hyperæmia and œdema with serous effusion in the lateral ventricles; fracture extending through petrous portion into right middle and posterior fossæ.

d. Head and eyes turned to the right; convulsive movements of left angle of mouth, and of right hand and arm. *Lesions:* No fracture; no lacerations; pial hemorrhage covering whole brain except frontal lobe; thickest in right middle and posterior parietal regions; was both above and below the tentorium; general cerebral hyperæmia and œdema.

e. Head and eyes turned to the right; left facial paralysis; slight twitching of the fingers of the right hand. *Lesions:* Inconsiderable pial hemorrhage over left fissure of Rolando; laceration of whole lateral surface of right temporal lobe, except at its tips, and of a narrow margin of its periphery; cortical hemorrhage which escaped through a wound in the dura mater and formed an epidural hemorrhage over the right temporal and posterior part of the right frontal lobe; cerebral thrombi and punctate extravasations; diastasis of left corneal suture.

f. Head and eyes turned to the left; left hemiplegia. *Lesions:* "Hemorrhage into the ventricle and around the bulb"—(Note made by coroner).

g. Head and eyes turned to the right; left hemiplegia. *Lesions:* Small epidural hemorrhage—about one drachm—in right middle fossa; subarachnoid serous effusion; general cerebral hyperæmia and œdema.

These post-mortem findings differ from those found in the more frequently reported cases of idiopathic origin. Those have been almost if not quite invariably gross structural changes in the brain tissue, the result of softening, cerebral hemorrhage, or morbid growth. These, so far as they were cortical or subcortical, were generally the hyperæmia and œdema common to all intracranial injuries. The more obvious lesions were superficial, the meningeal hemorrhages and inflammatory effusions. There were 2 cases of limited contusion of a single temporal convolution and 1 of a wide laceration of a temporal lobe; neither of these encroached upon the recognized motor centres for the head and eyes; and it is doubtful if those centres were compressed by either of the superficial hemorrhages or effusions.

4. One case of ptosis; accompanied partial loss of vision

in the corresponding eye and total loss in the other; and resulted from a gunshot wound in which the ball passed between the periosteum and orbital plates. (Other cases were included in facial paralysis.)

5. One case of strabismus; accompanied general, including double facial paralysis. (See General Paralysis.)

General paralysis of the ocular muscles was only observed in recovering cases. These were three in number.

Case LXIX.—*Fracture of the cranial base,* followed by a purulent discharge from the right ear and symptoms of arachnitis; no injury in orbital regions; left pupil continuously more or less widely dilated and irresponsive paralysis of all the muscles of the left eye, and paresis of those of the right; left facial paralysis.

Case LXX.—Patient fell down stairs headforemost; profuse epitaxis; much ecchymosis of both upper eyelids; pupils normal; diminished facial sensibility. Eight hours later, intense headache and diplopia. Fifth day: Exophthalmos of left eye, from paralysis of all the ocular muscles; optic neuritis in both eyes; impaired sensation in the course of distribution of the first and second divisions of the fifth nerve on the left side. Headache and diplopia disappeared in a week's time.

A third case is detailed in another connection.

A very large number of cases of paralysis have been cited in order that the correctness of the conclusions which they suggest may approach a mathematical demonstration.

An examination of the lesions of all forms of paralysis has shown a certain number of cases of unmistakable compression of the motor area or laceration of the motor track. It has also shown many others in which such injuries seem probable, as well as a still greater number in which they may have been possible. There has remained a considerable number of cases in which no focal lesion is apparent, and of which the interpretation must be in some degree conjectural. The lesion in these cases must be by exclusion a general lesion and therefore necessarily a contusion of the brain substance. The primary result of cerebral contusion as already noted is an anæmia followed by a hyperæmia from which, it has been demonstrated, there result nutritive changes indicated by œdema and cellular degeneration. In view of these pathological facts it is not difficult to understand the occurrence of a loss, impairment, or disorder of muscular function even in the absence of gross lesion of the motor centres. Nerve fibres or nerve cells may suffer either from the intracerebral pressure of distended veins or serous transudation, or from the degenerative processes.

While in the many instances in which the indirect pressure of an inconsiderable epidural hemorrhage, or the more direct pressure of a thin pial or cortical hemorrhage or moderate subarachnoid effusion, exerted upon the motor area may conceivably occasion a concurrent paralysis, it still seems more reasonable to suppose that as in the cases in which no such conditions exist it is independent of the superficial lesion.

It is difficult to explain the limitation of paralysis to a single extremity or to individual muscles when the whole cerebrum is laterally compressed by a large epidural hemorrhage, or when the whole motor area is uniformly covered by a subarachnoid effusion. It becomes more comprehensible, however, upon the supposition that the superficial pressure primarily affects the cerebrum as a whole; and that a resulting irregular general circulatory derangement and degenerative nutritive changes have a local manifestation in the corresponding cells or projection fibres.

Ataxia.—There was only one instance of ataxia noted; this was of the motor form and was in a case terminating in recovery. The patient, who had fallen from a truck and struck upon the back of his head, was primarily delirious and afterward slow of comprehension. He suffered much from occipital headache, and ocular examination disclosed advanced optic neuritis in the right eye with slight paralysis of the external rectus muscle. His temperature did not exceed 101° and his respiration was 12 in the minute for three days, normal for six days, and then 8 to 12 for two weeks with normal temperature. He was out of bed at the end of the third week, but walked with difficulty on account of muscular inco-ordination equally marked in both legs. The patellar reflexes were normal. He had no other symptoms except slight vertigo and some slowness of comprehension.

In one instance also there was some lack of co-ordination in the finger muscles. In this case there was a superficial parietal abscess just posterior to the motor area, and a general acute arachnitis.

Disorders of the Cutaneous, and Muscular or Tendinous Reflexes.—These disorders have no diagnostic importance. They were noted in about 15 per cent. of cases, and would probably have been found in much larger proportion if they had been sought in all cases, not only primarily, but throughout their progress. They occurred in the various modifications of normal conditions observed under other circumstances, and were not apparently influenced by concurrent symptoms, nor dependent upon the nature of attendant lesions. An analysis of 32 cases with necropsy occurring in the last 300 of the series afforded results which may be considered representative of all such cases.

Reflexes Increased	10
Patient unconscious	6
Patient conscious	3
Patient delirious	1
Concurrent muscular disorders	6
Reflexes Absent	16
Patient unconscious	12
Patient conscious	3
Patient delirious	1
Concurrent muscular disorders	8
Reflexes Unsymmetrical	6
Patient unconscious	3
Patient conscious	2
Patient delirious	1
Concurrent muscular disorders	2

It may be noted that neither the mental nor the general muscular condition greatly affected the nature of the reflex disorders. The muscles were rigid, convulsed or paralyzed, and the patient conscious or unconscious, in about the same proportion of cases whether the reflexes were lost or increased. They were paralyzed in only 5 instances, 1 of the face and 4 of hemiplegia.

The most careful examination post mortem fails to disclose any definite relation between evident lesions and the reflex phenomena. Large cortical and meningeal hemorrhages were rather disproportionately frequent; but meningeal contusion or inflammation, and subcortical without superficial lesion were also encountered; and all of these without reference to the particular reflex condition. The motor tract or area was not often specifically involved.

IX. Focal Symptoms.—Focal symptoms are referable to lesions of cranial nerves or of cerebral centres of control.

Cranial Nerves.—Such symptoms may be occasioned by lesion of the nerve at its origin, in its intracranial course, or at its cranial exit; and are manifested in functional loss or derangement.

Lesions of the olfactory nerve or bulb, or of its central origin occurred in nine cases, in all of which with possibly a single exception in which the method of examination is not stated, the effect of simple sensory irritation was carefully excluded. In each case but one the cranial base was fractured, and in all save one the patient recovered; but the special sense was not restored in either while under observation. In four cases the left frontal lobe was also injured.

CASES.

Case LXXI.—The patient lived one week after having been assaulted, all the time delirious and incapable of exhibiting subjective symptoms.

Lesions.—No epidural hemorrhage or meningeal effusion; extreme meningeal and cerebral contusion; laceration of left frontal lobe; right olfactory bulb disintegrated and involved in cortical clot; left bulb distended by internal hemorrhage.

Case LXXII.—Gunshot wound through right temporal fossa;

primary loss of the special senses of sight and smell; progressive exophthalmos. The eye was removed on the fifteenth day and the bullet found in the inferior portion of the right frontal lobe; middle basal fossa and orbital wall comminuted.

Case LXXIII.—The patient was thrown from a high cart and struck the ground upon the back of her head. She was primarily unconscious, and suffered a contusion of the right occipital region attended by severe localized pain and mastoid ecchymosis. Hearing was disordered until the fourth week. The special senses of smell and taste were primarily impaired and two years later were unimproved.

Case LXXIV.—A physician in a railway accident received a contusion of the right parietal region. Two days later symptoms appeared which still persisted after the lapse of several years. They were: dilatation of the left pupil with incomplete paralysis of all the left ocular muscles and levator of the upper eyelid; anæsthesia of the conjunctiva of the left eye and mucous membrane of the left nostril; complete loss of the sense of smell in the same nostril; excessive pain on the left side of the head and face in the course of distribution of all the branches of the fifth nerve.

Loss of sight so far as it depends upon implication of the optic nerve in a line of fracture through the optic foramen was noted in connection with the symptomatology of fracture; and some account given of the six cases observed. In a seventh case the loss of sight was evidently from intracranial injury, either of the optic nerve or in the course of the optic tract. The loss was not discovered until the fifth day and was temporary. The pupils were symmetrical and the optic disc was practically normal.

The paralysis and disorders of the ocular muscles from lesions of the third, fourth and sixth nerves, or of the brain itself, were described and illustrated in the consideration of muscular disorders in general. A case not cited in that connection is noted for the strict confinement of lesions to these nerves.

Case LXXV.—A man while dancing fell backward, striking his head upon the ballroom floor. He had no symptom of injury except a slight headache for thirty minutes. His right eyelid then began to droop, and ptosis was soon complete. Examination was made five hours later. There was no wound or evident contusion; ptosis of the right eye was still complete with external strabismus; there was also incomplete paralysis of all the right ocular muscles, diplopia and imperfect accommodation. The pupils and retina were normal, and there were no other symptoms then or thereafter.

Although some degree of facial paralysis is of frequent occurrence, its dependence upon lesions of the facial nerve is not often demonstrable. In one case only of the present series there was obvious compression of the nerve in its osseous course of exit; in this the bone was comminuted and the aqueductus Fallopii filled with clot. Fractures of the petrous portion are usually simple fissures without displacement; and facial like ocular paralysis seem to be the result of central lesion.

There was no instance in which disturbance of function of the fifth nerve was an independent focal symptom. In two cases of anosmia the sense of taste was lost or impaired, and in a third pain persisted in the course of distribution of its sensitive fibres. There was no case in which the muscles of mastication were affected, and very few in which facial paralysis was accompanied by anæsthesia.

Deafness resulted in many of the cases in which fracture through the petrous portion was attended by hemorrhage from the ear. It was doubtless often due to rupture of the tympanum and obstruction of the auditory canal; but in a certain number of cases it is fair to assume that the distribution of the auditory nerve was the seat of destructive injury.

Vertigo was a symptom in many cases of intracranial traumatism, and in the absence of probable basal fracture, especially when following profuse external hemorrhage from the ear or in conjunction with manifest evidences of cerebral contusion, should be regarded as a general rather than a focal symptom. If, on the other hand, vertigo is closely associated with an aural hemorrhage or serous discharge indicative of basal fracture, as happened in many cases, and the cerebral circulation apparently is not greatly disturbed, it would seem that local injury of the auditory nerve should equally be regarded as its efficient cause. Two cases will serve to illustrate this probable relation of vertigo to nerve injury.

Case LXXVI.—A man fell from a truck upon the back of his head. There was hemorrhage from the right ear which continued for twenty-four hours; headache, deafness, vertigo, and mastoid ecchymosis, together with the impairment of the special senses of taste and smell, which persisted for two weeks. Pulse and temperature were normal from the time of first observation on the tenth day and there were no general symptoms.

Case LXXVII.—A man while sleeping fell from a third-story window. On immediate admission to the hospital there was profuse serous discharge from the ear and severe vertigo aggravated by rising in bed or opening his eyes. The pulse was normal in force and frequency. On the eighth and ninth days he had epileptiform convulsions; and on the twentieth he began to have an inflammation of the mastoid region for which he was trephined with negative result. The temperature but once exceeded 99°.

Dysphagia was observed in 17 cases of which 13 were fatal. It was usually an incomplete paralysis, and in fatal cases was permanent. It was both an early and a late symptom, and in many instances was variable from day to day. Articulation as well as deglutition was difficult in 6 cases, and in a seventh it was alone affected. In 4 cases, 3 of meningeal effusion and 1 of pial hemorrhage into the basal fossa, there was no other assignable cause apparent for the dysphagia or aphonia than compression of the nerves which supply the lingual and pharyngeal muscles. In the 5 cases remaining the sole or essential gross lesion was in each a cerebral contusion; and in these it seems necessary to assume a lesion of the cerebral centre or centres of control. This view is strengthened by the fact that in 3 of the fatal, and in all of the recovering cases, there was evident lesion of the left frontal lobe which is adjacent to the controlling centres of these muscles.

The following cases are representative of the two forms of pharyngeal paresis.

Case LXXVIII.—The patient from the fourth day was delirious in varying degree till her death ten days later. There was difficulty in deglutition at intervals from the seventh day, and just before death dyspnœa and dysphagia were extreme.

Lesions.—Fracture through left occipital fossæ, extensive laceration of inferior surface of left frontal lobe, and all the basal fossæ filled with cortical clot; thin pial hemorrhage over entire left, and posterior half of the right hemisphere.

Case LXXIX.—Protracted hemorrhage and serous discharge from the ear; bronchitis which developed on the fifth day and began to subside on the seventh. No symptoms referable to intracranial injury were noted till the eleventh day, when there was occipital pain and rising temperature, followed by somnolence, continued rise of temperature to 104°, and rigidity of the cervical muscles. Still later there was active delirium and deafness. From the twenty-fifth to the thirtieth days hearing and articulation were wholly lost, the patient could communicate only by gesture. Dysphagia occurred somewhat suddenly, a little later than the aphonia. Death occurred on the forty-first day, following progressive emaciation, paralysis and anæsthesia of the left lower extremity, and loss of rectal and vesical control.

Lesions.—Fracture through outer portion of right petrous bone; no intracranial hemorrhages or cortical lacerations; thrombus in each lateral sinus from the torcular Herophili into the jugular foramen; patches of lymph upon the vertex; several ounces of turbid serum in the basal fossæ, and a membranous exudation covering the pons and inferior cerebellar surface; large serous effusion in the lateral ventricles.

Case LXXX.—The patient on admission to the hospital was unconscious, and later rational with slow cerebration. On the second day there was some dysphagia referred to the left side of the pharynx, and a barely perceptible left hemiplegia which was progressive but always slight and variable in degree. On the seventh day there was a very slight facial paralysis with loss of rectal and vesical control. Dysphagia continued till death from asthenia on the twenty-eighth day.

Lesions.—No fracture; no intracranial hemorrhage; no cerebral laceration; large subarachnoid serous effusion in the frontal region; excessive hyperæmia of the cerebrum with minute vessels everywhere filled with coagula.

Case LXXXI.—The patient's condition until the sixteenth day was characterized by stupor and increasing mental disturbance with moderate temperature. His speech then began to be thick and difficult to understand. Rectal and vesical control was lost, and he had delusions but was otherwise rational. His speech grew more difficult, and on the twenty-fifth day he had dysphagia. He died three days later, his temperature having risen to 109.4°; and was 109.6° forty-five minutes post mortem.

Lesions.—Fracture through right middle fossa; no intracranial hemorrhage; moderate subarachnoid serous effusion; marked left frontal atrophy; entire brain substance, including cerebellum and basal ganglia, hyperæmic and œdematous to an excessive degree.

Reference has been made to cyanosis and pulmonary œdema from compression of the pneumogastric nerve as a disorder of respiration. As a distinctive symptom the two conditions must concur. It is of only occasional occurrence, and is not usually associated with that compression of the respiratory ganglia which has been described, but is even more uniformly fatal. The compressing agent is blood derived from a pial or cortical hemorrhage into the posterior basal fossæ. The pressure exerted by an epidural extravasation is insufficient to inhibit function by reason of the intervention of the dura mater.

Case LXXXII.—The patient was found helpless in the street and unable to speak. His limbs were flexed and his muscles spastic. The left pupil was dilated, and neither pupil reacted to light or accommodation. There was slight mastoid ecchymosis. No disturbance of respiration; temperature 98°; pulse 120; respiration 24. On the third day the patient, previously quiet and apathetic, became restless, and soon afterward cyanotic with pulmonary œdema.

Lesions.—Two cranial fissures in inferior occipital fossa: one through groove for lateral sinus into the jugular foramen, the other into the foramen magnum; no epidural or pial hemorrhage; extensive laceration of inner border of cerebellar lobe; cortical hemorrhage in inferior occipital fossa.

Lingual paralysis was noticeable in but two instances; in one it persisted until the patient was discharged from the hospital, and in the other until his death. The first was unaccompanied by other paralysis, the second by facial paralysis and ptosis. It is probable also that in cases of dysphagia or aphonia the lingual muscles may have been in some degree involved.

It is evident from this summary of cases that in functional loss or derangement of parts to which cranial nerves are distributed these nerves are not necessarily at fault. The only focal symptom which is invariably chargeable to lesion of a cranial nerve is the cyanosis and pulmonary œdema which has been described. Diagnosis may be positive in one other condition. The implication of an optic nerve in a line of fracture through the optic foramen may be determined by ophthalmoscopic examination; with this exception the seat of lesion, whether of the nerve or cerebral centre, can be inferred only from the history of the case and the associated symptoms; and with how great a degree of certainty this can be done may be estimated from a study of the various histories which have been cited.

Cerebral Centres of Control.—A number of instances in which symptoms are occasioned by lesions of definite centres of control have been already noted. They include retardation and stoppage of respiration from compression of the respiratory ganglia, certain cases of paralysis from lesions of the motor area, and certain other cases of loss or impairment of the special senses of sight, smell and taste and loss of power in the muscles of the eye, tongue and pharynx. There remain mental derangement, exclusive of acute mania or delirium, and aphasia.

Mental Derangement.—The fatal cases in this series which were marked by distinctive symptoms of intellectual and emotional disturbances were cited in two monographs relating to localization of the mental faculties in the left prefrontal lobe.[19]

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[19] Phelps, American Journal of Medical Sciences, April–May, 1902; March, 1906.

They were supplemented by a certain number of cases terminating in recovery, and the subject was fully discussed and various considerations presented which substantiated a belief in the actuality of such a localization. It will be unnecessary therefore to do more than to reiterate the statement of conclusions then reached, and to reproduce from those publications two well marked antithetical cases; one of lesions of the left frontal, and one of the right frontal lobe. Those conclusions were:

1. Mental decadence always attends conjoint lesion of both prefrontal regions.

2. Mental decadence always attends lesion confined to the left prefrontal region.

3. Mental decadence never attends lesion confined to the right prefrontal region.

These postulates were based primarily upon a study of the cases proper to this series, and their correctness was confirmed by the records of other reported cases of traumatisms, abscesses, tumors and congenital defects, as well as by results of experimentation. The histories of all the original cases, 29 in number, were detailed, and while some were conclusive, none were contradictory and the greater number were convincing, as were those reported by other writers by whom these facts had not been recognized. If by chance exceptional cases should be encountered, which are inconsistent with the belief in the existence of such a localizing region, they need not be regarded as necessarily invalidating the results of positive clinical and post-mortem observation. It should be borne in mind that functional anomalies are often explicable by anomalies of cerebral structure; that, *e.g.*, the lesion has more than once been found to be upon the same side with a hemiplegia, and that the removal of the entire left temporal lobe was followed only by temporary right hemiplegia and doubtful hemianopsia; and that the observation of a single case led Trousseau to deny the truth of Broca's discovery. If the same nature and degree of proof which is deemed sufficient to establish centres for the localization of other cerebral functions may be accepted for the mental faculties, their centre of control has been established.

This localization, as it was stated, is simply one of topography and has no reference to the nature of the control exercised, whether one of co-ordination or of inhibition, or to the psychological theories of various authors. The fact that mentation has an anatomical substratum having been accepted as an almost axiomatic truth, it only remained to determine whether this physical basis was more or less precisely delimited or was generally diffused in the cerebrum.

Case LXXXIII (Abstracted from Case LX in Monograph of 1902).—The patient was primarily unconscious and in shock with widely dilated and irresponsive pupils; compound comminuted depressed fracture extending through the inferior portion of left parietal bone from coronal suture to mastoid process; much brain matter extruded and lost. The disintegrated brain area involved at least the posterior half of left frontal and upper part of left temporal lobe; just how much farther this area extended anteriorly and inferiorly could not be accurately determined without unjustifiable exploration. On regaining consciousness the patient muttered and laughed for fifteen minutes; on the second day he was irritable and irrational but not delirious; on the third day his speech was mere gibberish and he laughed and cried at intervals; on the seventh day he could understand English but could not speak it; in the second week he was actively delirious; in the third week he could speak a few words of English, was very emotional, and wore a peculiar fatuous smile. Before his injury he usually spoke in the Norwegian language; when he regained speech it was English only; his Norwegian vocabulary was afterward limited to a few words. At the end of three months he said if he were to return to work he would be unable to comprehend orders. He was still emotional and cried often, though his wife stated she had never heard him cry before he was injured; he had various manifestations of aphasia; his power of attention began to improve though his mental faculties were generally weakened. His symptoms, with the exception of long-continued dilatation and inaction of the pupils, were at all times confined to disorders of the mind and speech.

Case LXXXIV (Case VII of Monograph of 1906).—The patient was made primarily unconscious but walked several miles to a hospital. On admission he was very weak and somewhat apathetic but his mental condition was normal. On the following day some osseous fragments were removed from the right orbit and a cerebral cavity as large as an egg disclosed which had been formed by destruction of the anterior portion of the first, second, and third right orbital convolutions. There were no subsequent mental symptoms, and none of importance physically except some rise in temperature.

The following is illustrative of that class of cases with recovery in which left frontal lesion has been assumed to exist.

Case LXXXV.—The patient, who had no history of alcoholism, was primarily unconscious. On admission to the hospital he was still unconscious with normal pulse and temperature. He had a contusion of the right side of the head and neck, but no hemorrhage from the ear. He had also left facial paralysis and loss of vesical control; temperature on the third day rose to 102°. On the fourth day he could be aroused, and seemed vaguely conscious of what was said to him; he was emotional, his left leg and arm movements were unsteady, and reflexes on the left side were slightly exaggerated. On the eighth day he was able to sit up and talk rationally for two or three minutes at a time, but then became erratic. In the fourth week his facial paralysis had disappeared, the use of the left arm was normal, but the left lower extremity was still paretic. He was coherent but irrational and answered questions with a peculiar grin. He said variously that when improved he was going to the morgue, that he was going to some village (named), in Germany; that he was accompanied by seven men or by some other number which was variable; that he was in Bellevue learning to be an inspector of farms; and usually believed that he was in Germany.

At the time of his discharge from the hospital in the second month his mental condition was apparently normal.

There is often a single fixed delusion which is persistent, though perhaps accompanied by others which are transitory and variable, as in the case just cited; or as in Case LII of the collection of cases to which reference has heretofore been made,[20] in which a longshoreman who had fallen from a ship's deck was quite certain up to the time of his death, twenty-four days later, that he had fallen from a mulberry tree in Fordham; and described the occurrence with great and unvarying circumstantiality of detail. This case, which was one of laceration of both frontal lobes, escaped inclusion in the series of frontal lesions which it would have increased to thirty. The delusion as in these cases is perhaps most often one of locality. It may, however, be one of an entirely different nature as in Case CCLXXVIII of the same collection.[21] This patient suffered acute anguish for some weeks on account of the fancied death of his wife, and for many weeks afterward on account of the death of a child. He had never had either wife or child, as the other man had probably never seen either Fordham or a mulberry tree. The persistent delusion is sometimes unaccompanied by others, and may be of singular character; as in case of the hobo who had probably never worked in his life, and was honestly anxious to leave the hospital that he might get back to his work; or the man who confounded the sexes and thought every man he saw was a woman, and every woman a man.

The mental derangements which result from cerebral traumatism do not exactly correspond to any form of mental disease included in the nomenclature of the alienists, but the term traumatic dementia which has been sometimes used sufficiently serves the purpose.

Aphasia.—There were 30 cases in which aphasia was a symptom, 24 of which terminated in recovery.

It is perhaps a matter of interest rather than of importance that in 28 instances the subjects were males; and it is probable even that one of the two female subjects became aphasic from an apoplectic seizure rather than from the traumatism, since a week had elapsed from the time of injury without intervening symptoms; and the later loss of speech was attended by the usual symptoms of that form of cerebral hemorrhage. The accident or influence of sex parallels the sex condition in traumatic convulsions, in which 101 out of 110 patients were males; but while the greater frequency of convulsions in man may be explicable upon the supposition of a sexual difference in reaction to a general irritation, it is inconceivable that sex should affect the result of a structural injury of a cerebral centre. If males are more liable than females to suffer traumatic aphasia it can only be ascribed to a greater general exposure to intracranial injuries.

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[20] Traumatic Injuries of the Brain.

[21] *Lib. cit.*

There were certain attendant symptomatic conditions so often present as to be in a measure characteristic. These were in frequency and in detail:

Muscular disorders	27
Paralyses	18
Convulsions	4
Muscular rigidity	5
	27
Mental disorders distinctive of left prefrontal lesion	13
Loss of impairment of special senses	4

Six of the paralyses were hemiplegias, and the remainder were of the face, pharynx, or upper extremity.

The frequency of these concomitant symptoms is quite comprehensible in view of the propinquity of corresponding centres of control to those of speech. The area in which all these centres are localized, the frontal and temporal convolutions, in the island of Reil, and the margin of the Sylvian and Rolandic fissures, is so limited that the usual comprehension of two or more of them in a common lesion seems almost inevitable. In a majority of cases two or more centres were involved, not only associating different forms of aphasia with each other, but with one or more paralyses or with functional loss or impairment of special senses. The right hemiplegia which has been accounted a specially characteristic complication of aphasia was noted in only 6 cases, and paralysis limited to the right upper extremity in 3 others. There was in one instance the exceptional occurrence of paralysis of a corresponding extremity. The history of this case is appended. The paralyses were usually incomplete and often transient.

The general symptoms were as varied as in cases of cerebral injury in which the disturbance of speech was absent; and in some instances no general symptoms were observed. No complicating symptoms, aside from those which were mentioned as allied through community of lesion, was characteristic. As with other intracranial lesions that of the speech centres occurred with and without cranial fracture. There were 18 cases with fractured base, 4 with fractured vertex, and 8 in which no fracture had been sustained. The several forms of aphasia as they may co-exist in a given case cannot always be recognized on account of the concurrence of stupor or delirium, or as it sometimes happens because the patient speaks only in some unusual dialect for which no intelligent interpreter is obtainable. Their classification in the present series of cases so far as it was possible to be determined was:

Motor Aphasia	7
Sensory Aphasia	4
Sensory Motor	14

Motor aphasia was noted in 5 other cases in which the pressure or absence of sensory disturbance could not be ascertained on account of a condition of delirium or dementia or by reason of an unintelligible dialect. The varied forms of aphasia, motor, auditory and visual including paraphasia and agraphia, were all represented in this series. Their manifestations, however, were not different from those which have been described in other reported cases.

The aphasic condition was undoubtedly primary in 11 cases, and secondary in 5; positive knowledge of the time of its occurrence in the remaining 14 was wanting on account of the persistence of early unconsciousness, delirium, or stupor, or the lack of history prior to a late admission to the hospital. When known to be secondary it was first apparent from the second to the twelfth day; and in the doubtful cases it was first discovered within the same limits.

Aphasia persisted till final unconsciousness in all the fatal cases, and till the patient's discharge from the hospital, a period varying from eleven days to five months, in 9 of the 24 cases which terminated in recovery. In the remaining 15 cases, nearly two-thirds of those in which the patient survived, all aphasic symptoms, except at times some slight hesitation in speech, disappeared in from twelve days to three months. In five of those in which a notable degree of aphasia persisted at the time of last observation, improvement was still progressive and gave promise of complete restoration of motor and sensory function. The statistical prognosis therefore in traumatic cases may be considered good—much better than when the speech defects result from embolism or thrombosis.

Four of the 6 fatal cases afforded opportunity for post-mortem examination. The histories of 3 of these were detailed in the Monographs upon frontal localization, as was that of a case in which several forms of aphasia resulted from the growth of a tumor in the left frontal lobe. The relations of aphasic conditions to lesions in these cases is shown in the abstracts of histories which follow.

Case LXXXVI.—Primary delirium with paraphasia at end of two hours, both of which continued till final coma at the end of thirty-four hours. This patient could utter single words correctly, or a number of words in succession, each correct in itself but strung together without connection: as, "water—father—who," or "Jesus—now—who." He also connected fragments of words as: "en—is—other," meaning when is mother; or "ter—J," for water—Jesus. The clue was found in the words he constantly used.

Lesions.—Fracture and epidural hemorrhage confined to left occipital region and corresponding fossa; thrombus in left lateral and superior petrosal sinuses; moderate subarachnoid serous effusion; laceration involving the exact width and whole thickness of cortex of first and second left temporal convolutions, 1½ inches long, embracing the second and part of the third fifths of the first, and the middle portion of the second convolution, estimated from the anterior extremity; small and deep laceration in the centre of inferior surface of same lobe; small and shallow laceration at tip of the lobe, implicating all three convolutions; similar laceration at tip of right temporal lobe involving second and third convolutions; extensive laceration of inferior surface of left frontal lobe, extending from its anterior border to the optic chiasm and from the median line outward through first, second, and third orbital convolutions, and into the subcortex; cortical hemorrhage in middle portion of anterior fossæ, extending over sella turcica into middle fossæ; general cerebral contusion indicated by hyperæmia and thrombi in the minute vessels.

Case LXXXVII.—Paraphasia on the second day, followed on the third by aphemia which was permanent; later right hemiplegia, left facial paralysis, and paroxysms of facial spasm which became general; no sensory speech defects. Death on the sixth day.

Lesions.—Fracture through right middle fossa; general meningeal and cerebral hyperæmia, excessive on the left side; thrombosis of minute cerebral vessels throughout cortex on the left side; subarachnoid hæmatoma derived from rupture of left Sylvian artery, and extending along Sylvian to median fissure, 7 cm. wide in its broadest part; subjacent cortex eroded; neuroglia generally increased.

Case LXXXVIII.—Primary unconsciousness which continued till second day; muscles spastic; pupils unsymmetrical; lack of rectal and vesical control; single convulsion; aphemia discovered on the third day; visual aphasia and agraphia still later. Death on the eighth day.

Lesions.—Fracture of right parietal bone from anterior inferior angle to parietal eminence; epidural hemorrhage along line of fracture, with flattening and compression of the underlying convolutions; small hemorrhages into pia mater and subjacent cortex of the right frontal lobe, largest upon its inferior surface; extensive laceration of anterior two-thirds of left temporal, and of inferior surface of left frontal lobe; softening and infiltration with blood of inferior portion of first, second, and third left frontal convolutions; entire destruction of left island of Reil; areas of softening extending from Sylvian fissure to posterior commissure; cortical hemorrhage covering whole frontal lobe; general cerebral hyperæmia; hemorrhages of considerable size in all parts of the pons.

Case LXXXIX.—Primary unconsciousness and later mental derangements prevented examination as to speech defects until late in the third week; patient then paraphasic, and from that time was irrational or actively delirious and further examination was again precluded. There was no motor aphasia.

Lesions.—Pachymeningitis interna and externa; turbid serous effusion in basal fossæ; general cerebral sclerosis; atrophy of both frontal lobes, more marked in the left; abscess involving left temporal, and anterior part of left occipital lobe.

Case XC.—*Tumor.*—Motor, auditory, and visual aphasia; amusia and agraphia; all well marked and permanent. Death in the fourth month.

Lesions.—Tumor occupying anterior two-thirds of left frontal lobe; anterior border of Broca's convolution compressed, atrophied and forced backward, with substitution of tumor tissue for degenerated neural elements; inferior border of second convolution slightly involved. The cyst interrupted or displaced the efferent fibres of Broca's convolution; and destroyed all association fibres which entered or left the third, and many of those of the first and second convolutions. The general tissue of the brain presented a normal appearance except in those parts invaded or compressed by the neoplasm.

A point of interest in this case was a complete loss of a language acquired and constantly used in later years, and a reversion to one of childhood long since forgotten. He wrote and spoke in English as well as in French and German before his illness. After his coming to the hospital he spoke only in the Russian tongue which he had not spoken before in fourteen years, and was much annoyed that his attempts to speak in English or German failed. In still another case previously cited the patient had usually spoken in Norwegian, but when he regained the power of speech it was only English. He a little later recalled a few Norwegian words, but their number was not increased. His English vocabulary was gradually extended. Both patients could understand the language which they could not speak.

These observations made in cases with necropsy are supplemented by eight others in which the cranium was opened in operative procedure. Five were cases of compound fracture and three of explorative operation; all in the left fronto-parietal region. Cerebral laceration in the speech area existed in all the cases of compound fracture, but was discovered in none of those subjected to explorations. In one of the exploratory cases a minute pial clot with normal cerebral surface was disclosed; in a second, in which a large area was exposed, the dura mater was tense but on incision no lesion was apparent; and in the third there was temporary lack of cerebral pulsation, but again there was no evident gross lesion. In all the operative cases save one the patient survived.

There were cerebral lacerations corresponding to pre-existing aphasic conditions in all the cases with necropsy, and in three of those with operation for the relief of compound fracture. There were further lacerations in 5 of the 8 cases to which there had been no corresponding form of aphasia; but in each instance the discrepancy was more or less explicable by the persistence of unconsciousness, delirium, or other mental defect. In the two remaining compound fractures the site of injury was distant from the recognized centres of the speech defects observed; and as already stated no gross lesion was discovered in either of the cases in which aphasia was a symptom and exploratory operation was made.

There is no reason so far as these cases are concerned to question the accuracy of the generally accepted localization of centres of control for speech and allied forms of expression; but in several of the cases cited there is conclusive evidence that no gross lesion is essential to their loss. The case of tumor in the frontal lobe in which every sensory aphasic condition was strongly pronounced and in which lesions were strictly confined to the frontal lobe is a marked instance. It has been assumed that in the known or probable absence of cerebral laceration aphasia may result from the compression exerted by a hemorrhage. This assumption is neither substantiated by facts nor sustained by theoretical considerations.

There are in the present series of cases many in which, with consciousness retained and speech conditions normal, a considerable hemorrhage was found to extend over the speech area and there was no case in which, from cumulative hemorrhage in the same region consciousness was gradually lost before death or relief by operation, in which aphasic symptoms were observed at any time in its progress. There have been cases reported in which motor and perhaps other forms of aphasia have been attributed to small localized hemorrhages, but none in which lesion of the brain tissue has been excluded. In a case previously quoted,[22] a limited superficial hemorrhage was regarded as the cause of a motor aphasia; and though some improvement resulted, the continuance of the aphasic conditions for years afterward indicated a deeper seated lesion unrelieved by operation. The effect of a limited cortical hemorrhage would necessarily be lost in that of the underlying laceration and inevitable adjacent limited contusion.

Compression to be effective must be exerted with firmness and precision. The compressing force in epidural hemorrhage is so diffused and minimized by the fibrous shield of dura mater that even when excessive it is deficient in both essential conditions. It may be said in general that no form of intracranial hemorrhage can reasonably be expected to so compress a very limited cerebral area as to destroy its functional activity; when large the compressing force is too diffuse, and when small too slight to be efficient. Aside from this consideration the loss of consciousness which must always attend any large intracranial hemorrhage whether epidural or subdural, will of itself abrogate speech and all other manifestations of intellectual life.

It seems to be well established, therefore, that in aphasia, as with many other focal symptoms, there are many cases in which the essential lesion must be sought in some structural change invisible upon ordinary inspection, or at the most indicated only by some circulatory disturbance. The recovery of the patient in so large a proportion of cases, and the frequent strict limitation of the defect to a single one of its phases as well as its often transitory nature must serve to strengthen the conclusion that it is independent of the grosser forms of injury.

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[22] *Lib. cit.*

The comparatively short duration of aphasic conditions in some instances is illustrated in the two cases which follow. In two others, one of motor aphasia, and the other perhaps involving some sensory defect, it did not extend beyond the fourth day.

Case XCI.—A man 38 years of age was admitted to the hospital in an intoxicated condition, with no history and with profuse hemorrhage from the left ear. On the second day he was mentally confused and suffered much from vertigo and general headache. He was unable to state the place of his employment, and could only suggest his occupation of waiter by indicating in dumb show the use of a corkscrew. There were no pupillary symptoms at any time, no loss of rectal or vesical control, and no muscular disorders. On the seventh day his condition was in all respects normal. His temperature ranged 99.2°, 100°, 98°.

Case XCII.—A man who had been struck upon the head with a bottle was primarily unconscious; but on arrival of the ambulance had recovered consciousness. He could not give his name in speech but could write it. Motor aphasia with no sensory defect continued for eight days without general symptoms. He had sustained a fracture in the left temporoparietal region for which he was trephined and the osseous fragments were elevated and some small pieces removed. There was no evident intracranial lesion beyond a slight epidural hemorrhage.

There was no instance of the exceptional occurrence of left hemiplegia, but there was an instance of paralysis of the left face and left upper extremity which belongs to the same category and is susceptible of the same explanation without the necessity of supposing a cerebral anomaly—for the patient was not left-handed. There were probably bilateral lesions in this case, as has been often noted in other cases in which post-mortem examination was made.

Case XCIII.—The patient, a man 46 years of age, was knocked down in the street and was at once admitted to the hospital with paralysis of the left face and left upper extremity, slightly dilated and immovable pupils, and normal reflexes. He was semi-conscious; his temperature was 95°, pulse 60, and respiration 24; and he had no extracranial hemorrhages. On the second day he was incoherent and at times wildly delirious. On the third and fourth days his mental condition improved and motion in the upper extremity was restored. On the sixth day he became rational, could repeat single words when dictated, but could not recall his name. On the day following he could remember one of his names, but could not write it, and could not recall with certainty the names of familiar objects, and could not always repeat words or the names of things on dictation. Facial paralysis disappeared, but ptosis and diplopia persisted. On the tenth day he could repeat his full name and he could answer most questions with some hesitation.

The analysis of so large a number of cases, observed under similar conditions, could hardly fail to disclose some new facts in pathology and symptomatology, and to accentuate some others which were perhaps already known. The independence of the symptoms of cranial fracture and of intracranial lesions, the intervention of the sympathetic system in the production of symptoms of intracranial injury, and the relations of temperature to consciousness and in general to prognosis and diagnosis, are some of the more important of its disclosures; but the one fact of paramount importance which it establishes is that the essential lesion is the same in every class of intracranial injuries, and that it is a structural change in the cellular elements; that lacerations and hemorrhages are accidental, and not essential; that whatever influence these lesions may have in determining the more intimate pathological condition they are but a part of a general contusion which may equally occur in their absence. This is the inevitable conclusion which has resulted from the examination of every symptom in detail, focal as well as general, since in each instance many cases were found with no other gross lesion than a more or less well pronounced circulatory derangement or even with no evident change at all.

INJURIES OF THE KIDNEY.*

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On account of the position of the kidney in the abdomen, protected as it is by the spinal column, by thick layers of muscles, and by the thoracic wall, great force is necessary to injure it from behind; and its deep position protects it also from all but extreme degrees of violence from in front. Accordingly, injuries of the kidney are comparatively rare. In battle, injuries of the kidney, as the result of gunshot wounds, are probably fairly common, but in most of the cases associated grave injuries of the spine and of the abdominal viscera so commonly co-exist that the wounds rarely come under the care of the military surgeon. In civil life, also, gunshot and stab wounds of the kidney are relatively rare injuries. Contusions and ruptures of the kidney, as the result of blunt violence without external wound, are much more common; only very rarely are injuries of the kidney by blunt violence associated with an extensive contused and lacerated wound. As might be expected, all the forms of kidney injury are far more frequent in males than in females, and they are more frequent during the second and third decades of life than earlier or later; although in large cities, like New York, where run-over accidents are so common, a considerable proportion of the ruptures of the kidney occur in children. A large proportion of all subcutaneous injuries of the kidney are associated with grave traumatisms to the other abdominal viscera, to the spine, etc. Küster collected the statistics of 306 cases of injury to the kidney without external wound. He found that the right kidney was injured more often than the left, and that 93.98 per cent. of the cases were males, 6.02 per cent. females. A nearly similar proportion existed among children under fifteen years of age. Of these, there were 41 cases, and 33, or 80.48 per cent., were boys; only 8 were girls. Küster explained the infrequency of kidney injuries in the female not only by their less active mode of life and less frequent exposure to external violence, but also on account of the fact that the broader pelvis and more prominent crests of the ilia in women served to protect the kidney from direct violence. Further, that women usually have a thicker layer of fat; that their corsets also probably serve to protect them to some extent. The rarity of injuries of the kidney may be illustrated by the following facts: From January 1, 1890, to October 1, 1898, only 7 cases of injury to the kidney, requiring operation, entered the Roosevelt Hospital in the city of New York, a hospital where the accident service is very large. A number of cases of injury of the kidney other than these were treated in the hospital by conservative measures, the kidney lesion not being severe enough to merit operation. Of the cases operated upon, all were males, and all but 2 were young adults; the ages ranged between twenty-eight and ten years. In 5 of the cases the injury of the kidney was caused by the patient falling some distance and striking against some hard object, which injured the loin or the lateral wall of the belly. One case was crushed between two cable cars. In the seventh case the patient, who was riding a bicycle, collided with the shaft of a wagon, which penetrated his right pleura, diaphragm, peritoneum, liver, and caused a contused and lacerated wound of the right kidney (Dr. Robert Abbe's case). Thus 6 of these cases were subcutaneous injuries. Since 1898 only 6 cases of injury of the kidney requiring operation have come under my personal observation. One was a rupture of the liver, the kidney, and the lung. The patient, a child of nine years, survived. One was a rupture of both kidneys, ending fatally. One was a lacerated wound of the kidney, produced by a fractured twelfth rib; the broken end of the rib penetrated the substance of the kidney. A fourth was a gunshot wound of the kidney, associated with wounds of the intestine, diaphragm, and lung. The patient died. One was a stab wound of the kidney, requiring suture. One was a subcutaneous laceration of the kidney, requiring nephrectomy on account of persistent bleeding. I recall an unusual case seen by me when I was house surgeon in Bellevue Hospital in the service of Dr. Frank Hartley, a stab wound in the right loin, which opened the peritoneal cavity, wounded the liver, and made a deep cut into the substance of the right kidney. The knife entered between the ninth and tenth ribs, midway between the mammary and axillary lines, and transversed the right kidney from the outer to the inner border. A small urinary fistula persisted for six months.

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In 1896 Keen tabulated 155 cases of injury of the kidney. Of these, 19 were gunshot wounds, 8 were penetrating wounds of other descriptions, 118 were subcutaneous ruptures, 6 traumatic hydronephrosis, 2 partial nephrectomy for rupture, 2 ruptured ureter (pelvis). From these statistics one sees that subcutaneous ruptures of the kidney are far more common than open wounds. The injuries to the kidney substance vary much in severity, from slight contusions, attended by only a small amount of hæmaturia, to severe crushing injuries, in which the kidney may be pulpified or torn completely in two. The causes of rupture of the kidney are falls from a height in which the individual strikes some more or less prominent hard object, thus injuring the kidney by direct violence; or sudden and very forcible flexion of the trunk upon itself as the body strikes the ground. Other causes are blows upon the loin or the front of the abdomen, and sometimes violent muscular effort. The cases which I have seen of rupture of the kidney have been chiefly from falls or run-over accidents. Several cases of rupture of kidney from muscular violence have been observed. Thus, Clement Lucas reported the case of an elderly man who was walking behind a wagon loaded with heavy sacks; one of these fell to the ground, and he endeavored to catch it by grasping it suddenly with both hands. He felt a severe pain in the left side of the abdomen and back, and passed blood with his urine. A second case was reported by Campbell. A young girl of fourteen bent her body forcibly to the left side while jumping over a hedge. She immediately experienced severe pain in the region of the kidney, and passed blood with her urine.

While the mechanism of ruptures of the kidneys by direct violence, the result of crushing injuries or blows upon the front of the abdomen or the loin, is sufficiently clear, other cases of ruptures of the kidney occur in which the violence is exerted against some distant part of the body, as when the patient falls from a height, and suddenly flexes the trunk violently, either anteriorly or to one side. Ruptures of the kidney under these conditions have been explained by the theory of hydraulic pressure, sometimes by the pressure of the ribs. Unquestionably when the lower ribs are broken the kidney may be wounded, as in the case of my own cited above. It is comprehensible that as the result of a sudden violent commotion of the body the kidney might be projected by its own inertia against the transverse processes of the vertebræ, and thus injured. The explanation of ruptures of the kidney by hydraulic pressure was made satisfactorily by Küster, who tried a number of experiments upon kidneys removed from the body and produced ruptures of various kinds, indicating that a sudden increase of hydraulic pressure was the cause of the rupture. He also found that even in the bodies of old persons after the intestine had been removed sudden violent pressure upon the lower ribs of the left side caused the ribs to bend inward and to come into contact with the kidney. In ruptures of the kidney from hydraulic pressure the lines of rupture usually radiate from the hilum toward the twelfth rib. In cases of rupture of the kidney from muscular violence, it is assumed that the muscles acting upon the lower ribs cause them to move inward, and thus compress the kidney against the spinal column.

The character of the injury to the kidney varies, as stated, in a number of ways: In the cases which I have personally seen, in two a simple transverse fissure of the kidney existed, running from the hilum to the convex border. In one the kidney was completely torn in two at about its middle. In one a contusion of the kidney existed without rupture of the capsule, but with the laceration of an artery in the kidney substance of considerable size, so that an arterial hæmatoma or traumatic aneurism was produced, which bled the patient nearly to death in the course of about four weeks. In another case, operated upon in the Roosevelt Hospital by Dr. Frank Hartley, there was rupture of the kidney capsule, the kidney itself was extensively contused, and a very large hemorrhage had occurred into its interior, so that the organ was greatly increased in size. Much of the disorganization of the kidney substance had probably been caused by the pressure of extravasated blood. In another case, a child of ten years had a severe injury from a fall upon the right loin and suffered from marked hæmaturia. Exposure of the kidney for septic symptoms two weeks after the injury discovered a necrotic area in the substance of the kidney, rounded in shape, an inch in diameter, and about half an inch deep. In another case, where a man was crushed between two cable cars and developed some weeks later septic symptoms, a large tumor formed in the right loin; the kidney was found completely disintegrated at the time of the operation.

SUBCUTANEOUS INJURIES OF THE KIDNEY.

The various grades of subcutaneous injury to the kidney were classified by Schede into five groups:

1. *Injury of the Fatty Capsule of the Kidney and of the Fibrous Capsule without Injury of the Kidney Substance.*—In these cases there is usually a moderate effusion of blood between the kidney and its fatty capsule; the latter is more or less extensively infiltrated with blood, and may subsequently become thickened and indurated from the formation of new connective tissue. Occasionally the hæmatoma results in the formation of a cyst.

2. *Contusion of the Kidney with Hemorrhage.*—Contusion of the kidney substance with hemorrhage occurs, sometimes without gross lesion, sometimes with the formation of solitary or multiple fissures in the kidney, which may be trans-

verse or radiating, and are seldom parallel to the long axis of the organ. The ruptures do not extend into the renal pelvis. Such injuries of the kidney, although they may be accompanied by marked symptoms and hæmaturia, which may be profuse, rarely result fatally unless they become infected, or unless a considerable blood-vessel is torn with the formation of a traumatic aneurism.

3. *Fissures, Single or Multiple, in the Kidney Substance, for the Most Part Radiating from the Hilum, but Extending into the Renal Pelvis.*—In some of these, as in one of my own cases, the kidney may be completely torn in two. These cases are attended by profuse hemorrhage into the surrounding structures, into the fatty capsule, into the retroperitoneal tissues, or if the peritoneum in front of the kidney is also ruptured, into the abdominal cavity. The tendency of such hemorrhages is to spread downward into the mesentery of the small intestine, along the course of the spermatic vessels to the groin, into the scrotum, into the labia majora of the female, into the pelvis, and to appear superficially in the skin of the abdominal wall. These cases are very serious. The accompanying extravasation of the urine forms a dangerous complication; a considerable tumor is usually present in the loin after a few days. Hæmaturia may be absent, since the ureter is often plugged by a clot of blood. As a rule, unless operated upon, septic symptoms develop as the result of infection of the mixture of blood and urine, with the production of a large abscess or of a widespread necrotic inflammation of the retroperitoneal tissues. Late secondary hemorrhages may occur as the result of the necrotic process, and such may be fatal.

4. *Complete Pulpification of the Kidney.*—In these cases the kidney is extensively lacerated and torn, and considerable pieces of kidney tissue may be completely separated from the rest of the organ. The result is not dissimilar to class 3. Unless operated upon these patients die of hemorrhage or of septicæmia.

5. *Injuries of the Kidney, accompanied by Rupture of the*

Renal Vessels, Rupture of the Ureter, or Tearing Away the Vessels and the Renal Pelvis from the Kidney Itself.—In these cases, unless operated upon at once, death ensues from hemorrhage or from necrotic and putrid inflammation and septicæmia.

A sixth class might be added in which, in addition to the injury of the kidney, extensive multiple injuries of the other abdominal viscera or of the lung occur, and while always grave injuries, some of them are saved by prompt operation.

Symptoms, Course, and Diagnosis of Subcutaneous Injuries of the Kidney.—Since most cases of rupture of the kidney occur as the result of extreme degrees of external violence, the symptoms of more or less pronounced shock are usually present immediately after the injury, and are due, as in other cases of severe injury to the belly, to the violent mechanical disturbance of the sympathetic and abdominal plexuses of nerves rather than to any injury of the kidney itself. In other cases the symptoms of shock, even after very severe injuries of the kidney, may be entirely absent; the individual may continue to walk about, or even to work for several hours, until he begins to feel faint from internal bleeding, or until his attention is attracted to the presence of blood in his urine. Accompanying the shock, when present, nausea and vomiting are commonly observed, together with the other symptoms of shock.

Pain.—Following injuries of the kidney, severe pain is usually present at the time of the accident, although it may at first be slight, and gradually increase in intensity, as the effused blood causes tension and undue pressure upon the nerves of the kidney and its capsule, and upon the sensory nerves after their exit from the spinal column. The pain is referred to the region of the kidney, and often radiates downward along the course of the ureter into the bladder, the external genitals, and the inner surface of the thigh. External signs of injury in the neighborhood of the kidney may be present or absent; such may be abrasions, ecchymoses, the signs of a fractured rib, etc. Extreme tenderness over the injured kidney is present in all cases. If blood is poured out in considerable quantity in the vicinity of the kidney, a tumor mass will be formed behind the peritoneum, which may gradually increase in size for hours or days, and may extend well down to the umbilicus to one side of the median line, and be felt as a distinct tumor mass or as a mere sense of diffused resistance on palpation. Such effused blood may appear after a day or more upon the skin of the lower abdomen, in the region of the inguinal canal, in the scrotum, in the fold of the groin. Usually, if the effusion of blood is considerable, the patient will lie with the thigh of that side flexed to relieve the tension of the muscles of the back and of the abdominal wall.

Hæmaturia.—The most characteristic sign of injury to the kidney is the presence of blood in the urine. It is to be borne in mind, however, that in several groups of cases hæmaturia may be slight or absent. If the injury of the kidney involves merely the fatty capsule and the fibrous capsule without crushing or tearing the kidney substance, no blood will appear in the urine. In very severe injuries of the kidney—namely, those in which the ureter is torn across, or in which the ureter is soon plugged by a blood clot—the quantity of blood in the urine may be small, microscopic, or even absent. In the cases where the ureter is plugged by a clot the appearance of blood may be delayed for many hours or may be intermittent. In these cases attacks of renal colic may occur, followed by the evacuation of blood casts of the ureter. If the bleeding proceeds rapidly down the ureter into the bladder, the appearances will vary in different cases. The patient may urinate blood in large quantities mixed with urine. If the bladder was empty at the time of the accident, the organ may fill up with partly coagulated blood. In these cases the patient will suffer intense pain in the region of the bladder, will have a constant desire to urinate. The contractions of the bladder wall may, however, be insufficient to force the clotted blood through the urethra, so that complete retention may occur with the formation of a tumor above the pubes by the distended bladder. In other cases the patient may be able to empty the bladder partly, and will pass urine mixed with blood. From time to time the orifice of the urethra will be plugged by a clot and the stream of urine interrupted, causing severe pain. In these cases it may be necessary to empty the bladder with an evacuator, or to suck it out with a large hand syringe and a large metal catheter having one or more unusually wide eyes. In many cases the quantity of blood entering the bladder will be small; the urine will simply be colored slightly or deeply, and will appear not bright red, but smoky or a dull brown color, indicating that the blood has been in contact with the urine for some time. It is, of course, important to distinguish whether the blood comes from the bladder or from the kidney. This is sometimes possible. Usually in hemorrhage from the kidney the urine is evenly mixed with blood; in hemorrhage from the bladder, on the other hand, the last portion of urine passed often contains more blood than the first. The diagnosis may also be made by washing out the bladder. The bladder once evacuated and washed clean, if the hemorrhage comes from the kidney, further washings will be clear or but slightly stained with blood. If the hemorrhage comes from the bladder, repeated washings will usually appear blood-stained, since the mechanical distention of the bladder by the fluid introduced will usually be sufficient to keep up or to inaugurate fresh bleeding. The cystoscope will enable one to clear up the diagnosis in doubtful cases. If the hemorrhage comes from the bladder, the fluid medium will usually become opaque almost at once; if from the kidney, gushes of bloody urine, in case the bleeding is still going on, may be seen proceeding from the orifice of one or other of the ureters; or a clot may be seen adhering to the orifice of one ureter. If the bleeding has permanently or temporarily ceased, the cystoscopic field may be so clear as to enable us to eliminate the bladder as the source of blood. The passage of cylindrical blood casts of the ureter *per urethram,* while characteristic of renal hemorrhage, is inconstant. When the quantity of the blood in the urine is very large, it is seldom possible to make a differential diagnosis as to its source from microscopic examination. Injuries of the kidney are usually followed by a traumatic nephritis, and after a hemorrhage from the kidney has ceased, examination of the urine will often detect hyaline casts, sometimes containing granules, sometimes red blood cells and renal epithelium. Such a traumatic nephritis is associated with an albuminuria, and the quantity of albumin is greater than can be accounted for by the small quantity of blood present. Polyuria is frequently present in these cases. Traumatic nephritis is sometimes associated with œdema of the extremities, and even with generalized œdema. This is, however, a relatively rare occurrence. In the very extensive ruptures of the kidney the symptoms of internal hemorrhage may be present of any possible grade. In the worst cases the symptoms of progressive anæmia may increase from hour to hour, and unless operated upon the patient may bleed to death in a very short time. In such cases the local signs of the formation of a tumor mass in the region of the kidney will be marked. If the peritoneum has been ruptured, in addition to the signs and symptoms of hemorrhage, there will be evidences of an accumulation of blood in the peritoneal cavity. The hemorrhage following contusion of the kidney may be intermittent, notably if a considerable artery is torn without rupture of the kidney capsule. This is well illustrated by the following case observed in the Roosevelt Hospital in 1894:

The patient was a boy, aged sixteen years. A week before coming to the hospital he had fallen, while running, against a wooden beam, which had injured his right loin. He did not suffer from shock, and walked a considerable distance to his home, where he went to bed, and remained during the following week. He had observed that his urine was red after the accident. Upon admission to the hospital his temperature was 99° F., his pulse 100. He was passing a diminished quantity of urine, 14 ounces in twenty-four hours. This was slightly brownish in color, and contained a moderate amount of blood. There was pain in the region of the right kidney, moderate tenderness, and muscular rigidity. He left the hospital at the end of the three days feeling better, and desiring no further treatment. Twelve days later he returned. On the preceding day he had passed a large amount of blood *per urethram*. There was no tumor in the loin nor noticeable tenderness. At this time his pulse had become rapid, 110. He had a slight amount of fever. His urine contained some blood. Upon the two following days he passed a considerable quantity of blood with the urine. The bleeding continued during the next five days with the symptoms of progressive anæmia. Three weeks after the accident his right kidney was removed. The kidney was slightly enlarged. There was a bulging tumor at the centre of its convex border. Upon incising the kidney a considerable cavity was found in the kidney substance, an inch and a half in diameter. This cavity contained a globular clot of bright blood, inclosing firm clots and masses of fibrin, partly decolorized. In the wall of the cavity the open mouth of an artery of considerable size plugged with a soft and recent thrombus was discovered. The capsule of the kidney was not ruptured.

The course of a case in which the kidney was torn completely in two will serve to illustrate another type.

The patient was a man, aged twenty-two years, who was admitted to the Roosevelt Hospital, February 7, 1898. On the day of admission he had fallen, while walking along a beam, a distance of six feet, and had struck with his left loin on the end of a post. He suffered sudden, sharp pain in the loin, and exhibited symptoms of shock. Upon admission to the hospital, examination showed a large, robust man. He was very pale. His pulse was soft and slow, 72 beats per minute. Temperature normal. There was marked tenderness in the left loin over the kidney and abdominal rigidity in front. There was dulness on percussion in the left loin, extending forward as far as the vertical plane, passing through the anterior superior spine of the ilium. Half a pint of nearly pure blood was removed from the bladder by a catheter. The urine for the next two days was continuously bloody. The third day after the accident the blood had nearly disappeared from the urine. The patient was profoundly anæmic. He developed a septic temperature, 104.5° F., his pulse was 115. There was pain, rigidity, and marked bulging of the abdominal wall in the left hypochondriac region and posteriorly. On this day I removed his kidney through a cut parallel with the border of the ribs. Upon approaching the kidney a large retroperitoneal hæmatoma was opened, containing nearly a quart of fluid blood. At the bottom of this cavity the kidney was found torn transversely completely across into two equal portions. The torn edges and the adjoining kidney substance were extensively pulpified. The kidney was removed. Blood entirely disappeared from the urine after the operation, and thirty-four ounces of urine were passed during the first twenty-four hours. The patient made an uninterrupted recovery.

The following case history illustrates that a serious subcutaneous rupture of the kidney may be attended by trifling symptoms at first. In this case the kidney and the pelvis of the ureter were torn by a fall against a hard object.

The persistent hemorrhage would, no doubt, have caused the patient's death had not the kidney been removed.

A. C., male, aged fifty-nine years, native of France, a cook.

On July 6, 1907, at about 7 A.M., he was lowering a small cart down some stone steps. He stumbled and fell a distance of only two or three steps, striking on his left side against the edge of the lowest step. He experienced a sharp pain in his side, but arose, went about his work, and did not consider himself seriously hurt. He had some pain, like a stitch, in his left side, some difficulty in taking a deep breath, and that was all. Nearly eight hours later he had a strong desire to urinate; he went to the closet; urination was difficult and painful, and he observed that his urine was deeply stained with blood.

He sent for and was brought to the New York Hospital in an ambulance.

On Admission.—Patient is a large, stout, and fat man. Skin and mucous membranes normal in appearance. There is a fracture of the tenth rib on the left side about three inches from its anterior extremity.

Abdomen.—There is tenderness beneath the free border of the ribs in the left hypochondrium, and tenderness in the lumbar region of the same side. Temperature, 98.2° F.; pulse, 76; respirations, 20. The patient urinated liquor of a dark wine-color. The patient entered the service of Dr. F. W. Murray. He was kept quiet in bed. His urine continued bloody. On the eleventh day of July, four days after admission, his hæmoglobin was 60 per cent.; on the seventh day after admission it was 58 per cent.; on the ninth day after admission it was 52 per cent. On that day the left kidney was exposed by Dr. Murray through a five-inch incision parallel with the twelfth rib. The fatty capsule of the kidney was found infiltrated with blood. The kidney itself appeared swollen in its lower half. The capsule propria was incised and the incision gave exit to blood clots. The hæmatoma was cleaned out and the wound in the capsule drained by a strand of gauze. Suture of the external wound. The patient then fell under my care. From July 16th until July 19th the patient continued to pass bloody urine. He suffered from painful and difficult urination and much vesical tenesmus. On this day I again exposed the kidney through the same incision. A jagged rent was found in the posterior surface of the kidney near its lower pole. The tear extended from a point an inch and a half distant from the hilum inward and opened the pelvis of the ureter for a distance of an inch. The borders of the rent in the kidney substance were friable and appeared to be necrotic. The kidney was removed. The patient made a good and satisfactory convalescence. In addition to the lesions described, the kidney contained several small areas of contused tissue resembling infarcts. These areas were necrotic.

Operative Indications.—Only the more severe subcutaneous injuries of the kidney demand immediate operation, the indications being the rapid development of the general symptoms of hemorrhage—namely, acute progressive anæmia or the formation of a tumor mass surrounding the kidney combined with such symptoms or alarming hemorrhage through the ureters and bladder. A good many of the cases where the kidney substance is contused but the capsule is not ruptured, and where the contusion does not extend into the renal pelvis, are attended by only a moderate amount of hæmaturia, which gradually subsides, and is followed by a return to health. In the cases where a considerable artery is torn, with the formation of an arterial hæmatoma in the kidney, repeated hemorrhages of a severe grade constitute a positive indication for operation. In those cases where the capsule of the organ is torn and where blood and urine are extravasated into the surrounding tissues in the absence of indications for immediate operation on account of hemorrhage there will develop in the course of days or weeks septic symptoms which are accompanied by characteristic signs: The formation of a boggy, tender tumor in the loin, profound prostration, etc., and in these the operative indications will become quite plain. In the cases attended by severe degrees of shock, or accompanied by injury of other important organs, the operative indications must be diagnosticated upon general principles. The surgeon will seek to differentiate the symptoms of shock and hemorrhage. If the symptoms of shock are gradually recovered from in the course of hours, the surgeon may safely wait, unless the amount of bleeding from the kidney is alarming or unless the symptoms of internal hemorrhage are manifest. Those ruptures of the kidney, accompanied by laceration of the peritoneum and extravasation of blood into the peritoneal cavity, will be attended by the symptoms of peritoneal irritation, and, if not operated upon, by peritonitis. The general signs and symptoms of severe abdominal injury, the history of the accident, the presence of severe abdominal pain, rigidity of the abdominal wall, will furnish indications for immediate operation, as in other injuries of the abdomen.

INCISED AND STAB WOUNDS OF THE KIDNEY.

Incised and stab wounds of the kidney are rare injuries as compared with subcutaneous lacerations. The recorded cases in modern publications appear to number less than one hundred. In the American Civil War no case of incised or punctured wound was recorded (Otis). The wounds have been produced by cuts and thrusts with knives, daggers, bayonets, rapiers, scythes, scissors, rarely by impalement on sharp stakes; in one case (Murphy) a man fell upon the handle of a hayfork, which entered the rectum, penetrated the colon, and crushed the upper pole of the left kidney. In Abbe's case the pole of a wagon entered the thorax, wounding the pleura, liver, and kidney. The wounds have varied in size from narrow punctures to incisions wide enough to permit the prolapse of kidney. Wounds made in front have usually been complicated by injury of other abdominal viscera. Wounds made from behind usually involve the pleura, sometimes the liver.

Signs, Symptoms, and Diagnosis of Incised and Stab Wounds of the Kidney.—From the size, situation, and depth of a wound, injury of the kidney may be visible on inspection or palpation. In other cases the injury may be inferred more or less certainly from concomitant signs and symptoms, or from the character and length of the instrument which produced it, the degree of violence, and the direction of its application.

The free escape of urine from the wound indicates injury of the kidney, involving the pelvis or a wound of the ureter; hæmaturia will usually co-exist. In wounds of the cortical substance merely, both of these signs will usually be absent, or a small amount of transient hæmaturia alone may occur. Urine escaping from the external wound, either alone or mixed with blood, may be recognized by the urinous or ammoniacal odor soon developed in the saturated dressings. If the size, situation, and shape of the wound in the abdominal wall be unfavorable for its escape, the urine will be extravasated into the perirenal tissues or into the peritoneal cavity, and a septic inflammation or a peritonitis will follow, as the case may be, giving rise to characteristic symptoms and signs—*i.e.*, localized pain and tenderness, a boggy swelling in the loin, fever, prostration, etc., or evidences of peritoneal irritation if the extravasation has taken place into the peritoneal sac.

Hæmaturia.—As stated, when the renal pelvis is opened, the appearance of blood in the urine may be almost immediate, and this sign, together with the situation of the wound, is almost certain proof of a wound of the kidney; a wound of the ureter or its pelvis is the sole alternative. Hæmaturia may be absent if the cortex only is wounded, or if the ureter or pelvis is completely divided, or if the ureter is plugged by a clot, or if a large renal vessel be divided, so that much blood escapes into the peritoneum, into the perirenal tissues, or externally. In some cases blood will accumulate in the bladder, giving rise to vesical tenesmus and frequency, sometimes to retention, as described under Subcutaneous Injuries of the Kidney. Hæmaturia may be delayed for hours, even for days, and may be small in amount, or so severe as to cause death from loss or shock.

The symptoms of shock and the general symptoms of hemorrhage may be present or absent, and possess no distinctive diagnostic importance.

Pain.—Incised wounds of the kidney are not necessarily very painful. The external wound causes pain similar to that of any wound, but the wound of the kidney itself is not accompanied by severe pain unless the tension of the capsule of the organ is increased by blood extravasated beneath it, or unless the pelvis or ureter is plugged by a clot; there will then occur severe pain of a spasmodic character, a typical renal colic, often associated with nausea and vomiting. The pain radiates downward along the ureter into the groin and testis; the latter is retracted. The development of wound infection, of urinary infiltration, or of peritonitis will be accompanied by pain of a character described elsewhere.

To sum up the early diagnostic features of wounds of the kidney I quote from Henry Morris:

(1) That a wound of the renal region followed by the escape of urine through the wound is conclusive of injury of the kidney; (2) that such a wound quickly followed by the discharge *per urethram* of urine heavily mixed with blood is almost conclusive, if not quite so; (3) that such a wound followed by retention of urine, or lumbar or abdominal pain and dysuria, even without hæmaturia, is highly suggestive of a superficial wound and blockage of the ureter; (4) that hæmaturia followed by traumatic peritonitis is strong evidence of an injured kidney.

The following case of stab wound of the kidney was recently treated by me in the New York Hospital:

William C., aged thirty-nine, native of the United States. Foreman of a gang of workmen employed in the construction of a building close by the hospital. At 3 P.M. on September 4, 1906, he got into an altercation with an Italian peddler who was obstructing the sidewalk; as the foreman turned to walk away the peddler stabbed him in the back with a knife having a blade four inches long, sharpened on both edges and three-quarters of an inch wide. The wounded man felt weak and sick; he walked into the hospital, two hundred feet away. He had no pain. Upon admission, examination showed him to be a large, muscular, well-nourished man. He looked pale, his pulse was rather rapid; sole complaint, a feeling of weakness. Upon inspecting the seat of injury, there was a linear wound—three-fourths of an inch long running obliquely downward and forward—situated four inches from the middle line of the back upon the right side, between the eleventh and twelfth ribs. The wound scarcely bled. There were no signs indicating injury of the pleura or lung. After being in the hospital half an hour he urinated three ounces of bright blood.

A diagnosis was made of stab wound of the right kidney. The patient was kept under observation until the following morning, when the continued presence of large quantities of blood in the urine caused me to expose the kidney through an incision below and parallel to the last rib. A portion of this rib was removed to permit easier access to the kidney. There was a hæmatoma of moderate size in the perirenal fat. The kidney was freed and delivered into the external wound. A horizontal linear wound three-quarters of an inch long was then seen on the posterior surface of the organ near the outer border; this wound bled freely as the result of the manipulations. A blunt instrument passed freely through the kidney into the ureteric pelvis. The wound in the kidney was sutured and the bleeding stopped by a single mattress stitch of catgut. The operation wound was then closed in layers, except for the posterior angle, where a gauze wick was introduced down to the kidney. The stab wound in the external soft parts was let alone. After the operation the hæmaturia was at once reduced to a minimum and soon ceased. Primary union was obtained in the sutured portion of the wound and no apparent leakage of urine took place. The patient had a rapid and normal convalescence and was able to return to his work in a few weeks.

Prolapse of the Kidney through a Wound.—Wounds in the lumbar region below the ribs, if of sufficient size, have been followed in a number of instances by total or partial prolapse of the kidney; the kidney may or may not be injured. The prolapse has occurred at once from increased intra-abdominal tension, produced by coughing or vomiting, or at a later period. Constriction of the pedicle of the kidney by the wound margins, usually sufficient only to occlude the renal vein, causes swelling and congestion of the organ, profuse hemorrhage from an existent wound of the kidney itself, or, in other cases, hæmaturia. If the kidney remains unreduced, thrombosis of its vessels occurs, followed by gangrene. The diagnosis is to be made on inspection if the prolapse is complete; if partial only, digital exploration would at once reveal the characteristic shape of the kidney.

The Prognosis of Incised Wounds of the Kidney.—The prognosis of incised wounds of the kidney varies within wide limits, according to the presence or absence of complicating injuries. Simple incised wounds of kidney cortex heal well if not infected, usually *per primam.* Injury of the renal artery or vein is attended by such severe bleeding that speedy death results unless immediate surgical aid is at hand. Death from sepsis due to urinary infiltration, or from peritonitis, is common in untreated cases; a wound opening the renal pelvis or the peritoneum has probably been present in many of these. In some cases death has been due to nephritis; to uræmia from suppression of urine; in a few cystitis has been recorded as the cause of death.

Among 8 cases tabulated by Keen, 6 recovered and 4 died —1 from uræmia, 1 from sepsis and abscess of the liver. In 12 cases reported by Edler death occurred in 5, and was due to primary bleeding twice, twice to secondary bleeding, in 1 death followed nephrectomy. Among Keen's cases, 4 were treated by nephrectomy; all recovered. Küster collected 43 cases with 10 deaths; among these cases many had severe complications. Of 31 uncomplicated cases, but 4 died. The prognosis is profoundly modified by prompt and efficient treatment and, on the other hand, by neglect.

GUNSHOT WOUNDS OF THE KIDNEY.

Bullet wounds of the kidney uncomplicated by other serious injuries are rare; the renal vessels, the pleura, lung, diaphragm, liver, stomach, spine, etc., are very commonly injured as well; such wounds are so rapidly fatal that, when received in battle, they rarely come under treatment. The explosive effect of the high-powered rifle bullet is well marked on the kidney; the organ is often found torn in all directions or reduced to a pulp; even wounds from pistol bullets show a considerable degree of laceration of kidney tissue. Simple perforations from high-powered rifle bullets are only seen at extreme ranges. Among the cases of pistol-shot wounds, if the bullet merely grooves the cortex, or if the injury is confined to the cortex, the prognosis is much better than though the pelvis and the renal vessels are injured. Small pistol bullets fired at low velocities may perforate the kidney without producing very serious damage, and a number of such cases have, undoubtedly, recovered without operative interference.

In the simpler forms of gunshot wound of the kidney hemorrhage is not usually very profuse. The dangers are shock from complicating injuries; hemorrhage from injuries of the renal vessels, sepsis from wound infection, caused by unclean manipulations of the wound, from extravasation of urine, from the entrance of foreign bodies—*i.e.*, portions of clothing along with the bullet; from an ascending infection caused by imperfect asepsis in catheterization, the production of cystitis and infection of one or both kidneys.

The number of recorded cases of gunshot wounds of the kidney in which no other important structure has been wounded is not very large. In warfare the frequency of gunshot wounds of the kidney was estimated by Edler, and independently by Küster, at 0.12 per cent. of all wounds. Statistics compiled from a number of sources indicate that penetrating gunshot wounds of the abdomen involve the kidney in about 7.3 per cent. of the cases. The following statistics give some idea of the mortality in gunshot wounds of the kidney.

In the American Civil War 85 such wounds were followed by 26 recoveries and 59 deaths—a mortality of 69.41 per cent. In the Franco-Prussian War, among 15 gunshot wounds of the kidney there were 8 deaths and 7 recoveries—a mortality of 53.33 (Küster). These results represent wounds from large soft-lead bullets in pre-antiseptic days. The prognosis of wounds of the kidney occurring in civil life, such being, for the most part, pistol-shot wounds, is notably better; thus, Küster collected 29 such cases, with 21 recoveries and 8 deaths—a mortality of 28.41 per cent. The prognosis is, as already stated, profoundly modified by associated injuries.

Experiences gained in recent wars seem to show that uncomplicated wounds of the kidney produced by small-calibre rifle bullets at long ranges may be simple perforations, and so long as they do not open the pelvis or injure the renal vessels may heal without operative interference and without trouble. It is to be borne in mind that though no serious bleeding may occur immediately, the separation of the eschar produced by the bullet, at the end of five to ten days, may be followed by serious or even fatal secondary hemorrhage, evidenced by profuse hæmaturia or by the formation of a perirenal hæmatoma, or by bleeding from the external wound. In some cases the colon has been wounded and the blood has escaped *per rectum.* Infection and perirenal suppuration are quite prone to occur; a certain number of instances of this kind have been observed as the result of the passage of a foreign body, usually a piece of cloth, into the wound, and, in a few instances, such fragments of cloth have eventually been passed *per urethram* after months of perirenal suppuration, pyelitis, and cystitis.

Diagnosis of Gunshot Wounds Involving the Kidney.—The diagnosis of gunshot wounds involving the kidney may sometimes be made from the objective signs of injury of the kidney, as already described; in other cases the symptoms will be those of shock and intra-abdominal bleeding, as in stab and incised wounds. The cardinal signs are *hæmaturia* and the *escape of urine* from the external wound. Owing to the narrow wound of entrance, this latter sign is much less common in gunshot injuries. If the ureter is plugged by a clot, severe renal colic may be present.

In gunshot wounds involving the abdominal viscera, operated upon for the control of bleeding or for the repair of wounds of the hollow viscera, it will be rare that the surgeon can diagnosticate injury of the kidney before opening the obdomen, unless hæmaturia or kidney colic have existed. The anatomical site of the wound and the direction of the wound canal may aid in the diagnosis, notably when made by a small-calibered jacketed rifle bullet, since, as stated elsewhere, these bullets pursue a straight course through the body. The track of a soft-lead pistol bullet through the tissues, on the other hand, can only be surmised, deflection being caused by bones, tendons, and fascial planes in a large proportion of cases. The location of a lodged bullet may be determined by means of stereoscopic radiographs or with one or other form of localizer; such measures might possibly locate a bullet lodged in the kidney, but would scarcely be of much diagnostic aid in ordinary cases.

THE SURGICAL CONCEPTION OF PANCREATITIS.*

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THE surgery of the pancreas has, until quite recent years, consisted in the rather infrequent incision and drainage of pancreatic cysts and the drainage of effusions into the lesser peritoneal sac, the so-called pseudocysts of the pancreas. At the present time, however, there is rapidly coming a better understanding of pancreatic disease, and, owing to the investigations and writings of Robson, Moynihan, Cammidge, Opie, and others, not only the importance and the prevalence of inflammatory diseases of this essential and dual organ, but also the means of diagnosis of these conditions, are becoming more generally appreciated and are gaining the attention which their importance demands.

The frequent occurrence of cholelithiasis as the essential etiological factor in pancreatitis demands most thoughtful consideration, as must the fact that pancreatitis may eventually become an incurable condition, or, by extension of the inflammatory process to the islands of Langerhans, result in intractable diabetes. A more general recognition of these facts cannot do otherwise than stimulate the profession to earlier and more frequent surgical removal of gall-stones, as a prophylactic measure aimed against a probable pancreatitis and a possible diabetes.

Introductory to a presentation of the surgical conception of pancreatitis, certain rather elementary statements concerning the surgical anatomy and relations of the pancreas will assist in the ready grasp of the main points at issue, which fact must serve as an excuse for presenting them at this time.

The pancreas, a long, narrow, lobulated organ, from five to six inches in length, extending from the concavity of the second and third portions of the duodenum to the inner border of the spleen, is situated mainly in the epigastrium, behind the stomach and the lesser peritoneal cavity. Its head is not only intimately connected with the duodenum, enveloping about one-third of the circumference of that organ, but the upper portion of its anterior surface is also attached by areolar tissue to the transverse colon. The narrow, constricted portion of the pancreas, known as the neck, is in contact with the first portion of the duodenum and with the pylorus whenever the stomach is distended.

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The anterior surface of the body is covered by peritoneum, forming the posterior wall of the lesser peritoneal sac, lying between it and the stomach, while the posterior surface of the entire organ is devoid of peritoneum, being directly attached by areolar tissue to the posterior abdominal wall and to adjacent organs and structures. The posterior surface of the head is channelled by a groove, or pierced by a canal, in which lies the common bile-duct.

The main secretory duct of the gland, the duct of Wirsung, having its origin from small radicles in the tail, passes transversely toward the right through the body, but as it enters the head it swerves backward and downward until it comes into rather close contact with the common bile-duct, and together these two ducts penetrate the wall of the second portion of the duodenum and open into its lumen about four inches below the pylorus. A second or subsidiary duct, the duct of Santorini, draining only the head of the pancreas and being of functional importance in less than fifty per cent. of individuals, opens as a rule into the duodenum from three-fourths of an inch to an inch above the opening of the duct of Wirsung. Occasionally the secondary duct empties into that of Wirsung a short distance above the junction of the latter with the common bile-duct, or it may open by one extremity into the duodenum and by the other into the duct of Wirsung.

A rare but, from a surgical standpoint, an important anomaly of the pancreas consists in the complete investment of the duodenum by the head of the pancreas. Enlargement or distortion of the head under such a condition, by either new growth or inflammation, may so encroach upon the duodenum as to produce obstruction of the bowel, attended by the symptoms of pyloric obstruction. A more common, but still rare, anomaly is the occurrence of an isolated mass of pancreatic tissue, generally situated in the muscular layer of the wall of the small intestine and opening into the lumen of the bowel by an individual duct.

The infections of the bile-tract, either with or without the presence of gall-stones, are such important etiological factors in pancreatitis that a study of the relations of the common duct to the pancreas and its excretory duct materially assists in arriving at our conception of the surgical nature of pancreatitis. The first and second, the supraduodenal and the retroduodenal portions of the common bile-duct possess no anatomical relations of importance in connection with pancreatitis, but the relations of the third, or pancreatic portion, and the fourth, or intraparietal portion, lying within the structures of the wall of the duodenum, are of the greatest etiological importance.

According to Helly, the pancreatic portion of the duct, which is in contact with the pancreas for a distance varying from 2 to 7 cm., ran in a canal completely surrounded by pancreatic tissue in 62.5 per cent. of the cases examined by him, while it ran through a groove on the posterior surface of the gland in but 37.5 per cent. In 58 subjects examined by Bunger, the bile-duct was completely covered by glandular tissue in 55 and ran uncovered in a groove in 3 only. Moynihan dissected the pancreatic portion of the common bile-duct in 20 cases and found the duct completely covered in 13 and lying in a deep groove, overlapped, but not completely covered, by pancreatic tissue in 7 only. The important bearing of these varying relations of the bile-duct to the pancreas becomes at once apparent in the consideration of possible obstruction of the common duct due to the pressure of the swollen head of the gland in pancreatitis and in malignant disease. Swelling of the head of the gland is certain to seriously impede, if not obstruct, the outflow of the bile in that large proportion of cases in which the lobules of the gland completely surround the bile-duct, while the latter structure is as sure to escape compression by being displaced to one side when more fortunately, although less frequently, situated in a groove uncovered by pancreatic tissue.

In October, 1908, I operated upon a case of chronic pancreatitis, secondary to cholelithiasis, with that profound stationary jaundice so characteristic of pancreatic obstruction, as contrasted with the ebb and flow of the jaundice in obstruction of the common duct by stone, in which a painstaking examination of the bile-ducts proved the absence of stone in the common duct, but showed that the duct was entirely surrounded by pancreatic tissue, the enormous swelling of which had completely obstructed its lumen.

In another case of chronic pancreatitis, secondary to cholelithiasis, operated upon November 4, 1908, for Drs. Reynolds and Rohne of Defiance, in which there was no jaundice, with no stone in the common duct, but with 4 stones in the cystic duct and 53 in the gall-bladder, there was swelling of the head of the pancreas almost as great as in the above-mentioned case, but with absolutely no obstruction of the common duct. Evidently the pancreatic portion of the duct in this case was either in a groove on the surface of the gland or, at least, too superficially situated to be affected by the glandular swelling. Access to the head of the pancreas, in each case, was gained by mobilization of the duodenum as in Kocher's gastroduodenostomy, with inward displacement of the duodenum and lifting forward of the head of the pancreas.

The various modes of termination of the common bile-duct and the pancreatic duct in the duodenum are of great interest in this connection. Four distinct modes of termination are described by Letulle and Nattan-Lorrier, although there is but slight practical difference between the third and fourth. In the first, which is the usual mode of termination, the common bile-duct, lying above, and the pancreatic duct, lying below, unite to form a common, oval-shaped canal in the wall of the duodenum, the ampulla of Vater. The duodenal opening of the ampulla is the narrowest portion of the bile-tract, having an average diameter, according to Opie, of but 2.5 mm. In the second mode of termination the two ducts unite before reaching the duodenum, forming a common canal or duct opening into the duodenum by a small, flat, elliptical opening, no ampulla being present. In the third type, the two ducts open side by side into a depression or fossa in the wall of the duodenum; while in the fourth, the independent orifices of the ducts open at the summit of an elevation or caruncle. No ampulla is present in this type. In the later consideration of pancreatitis secondary to cholelithiasis, with the presence of a stone in the ampulla, or in the distal extremity of the common duct, the importance of the mode of termination of the bile- and pancreatic-ducts will become apparent.

As has been shown above, the head of the pancreas is in intimate relation with the duodenum and, naturally, it may be seen that either inflammation or malignant disease of the one may involve the other.

The close relation of the stomach, especially the pyloric portion, the favorite site of gastric cancer, with the pancreas, makes possible the secondary involvement of the pancreas in cancer of the former, a condition which, of course, contraindicates a gastrectomy which otherwise might be indicated. This was strikingly illustrated in a case operated upon by me a few weeks ago, in which a partial gastrectomy for cancer of the lesser curvature of the stomach, with no apparent symptoms of pancreatic involvement, seemed to be indicated until operative exploration disclosed, not only adhesion of the stomach to the pancreas, but also the involvement of the latter organ in the malignant process.

Adhesions between the stomach and the pancreas resulting from disease of either organ, as in ulcer of the one or inflammation of the other, not only materially complicate the indicated operative procedure, but also add greatly to the rate of operative mortality. These results are especially evident in malignant disease of the stomach involving the pancreas. Mikulicz found in 91 partial gastrectomies with no operative injury to the pancreas, a mortality of 27.5 per cent., but a mortality of 70 per cent. in 30 cases in which the pancreas was injured or in which, from operative necessity, a portion of the pancreas was removed. The lesson to be drawn from his experience and deductions is self-evident.

Ulcer of the posterior wall of the pyloric portion of the stomach, especially when approaching a condition threatening perforation, may lead to adhesions between the stomach and pancreas with subsequent secondary infection of the latter. Mayo Robson reports an interesting case, in which ulcer of the stomach, by adhesion and extension of infection to the pancreas, provoked an acute pancreatitis, with the subsequent formation of a pancreatic abscess which eventually ruptured into the stomach and was cured by stomach and pancreatic drainage by means of a gastrojejunostomy.

Operative procedures on the stomach necessitating the separation of adhesions between it and the pancreas, the result of gastric ulcer, must be conducted with the greatest regard for the preservation of the integrity of the pancreas, as the chances of a successful operative issue diminish in inverse ratio to the amount of injury to the pancreas.

The fact that the peritoneum, reflected over the anterior surface of the pancreas, forms the posterior wall of the lesser peritoneal cavity, is of the utmost surgical importance. Much confusion has arisen over the pathology of, and the differential diagnosis between, true pancreatic cysts and effusions of fluid into this lesser peritoneal sac, the so-called pseudocysts of the pancreas. Jordan Lloyd, in 1892, called attention to the differences distinguishing the two conditions, and yet to-day we read case reports of the two conditions, hopelessly confounded, in the same paper and under the same title. The employment of the term "pseudocyst of the pancreas" is unfortunate because misleading and begetting a false idea in pathology. True cysts originate within the glandular tissue of the organ itself and are covered with, and separated from the lesser peritoneal cavity by, the layer of peritoneum covering the anterior surface of the pancreas. Effusions of fluid into the lesser peritoneal cavity, while they may result from injury or disease of the pancreas, are entirely, originally and ultimately, outside of that organ and separated from it by peritoneum. The differential diagnosis between the two conditions is difficult and at times impossible. Owing to this fact, to mistaken ideas in pathology, and to faulty deductions from necessarily hasty and incomplete investigations upon the operating table, unquestionably many cases of effusion into the lesser peritoneal sac are reported in the literature of pancreatic disease, classified as true cysts of the pancreas.

A most interesting case of effusion into the lesser peritoneal sac was referred to me for operation by Drs. Sharpe and Grosh. From a slight elevation of the abdominal wall over the stomach, present when first seen, this patient developed in four day's time an enormous fluid distention of the entire upper central abdominal cavity. A history of preceding attacks of biliary colic and the presence of a mild degree of jaundice led to a diagnosis of pancreatitis secondary to cholelithiasis with, owing to the rapid increase in size of the abdominal swelling, an effusion into the lesser sac, probably hemorrhagic in nature. Operation showed the lesser sac to be distended with blood, bile, and pancreatic fluid. Two moderate-sized gall-stones and the disintegrated remains of others were removed from the lesser cavity well over to its left extremity. The common bile duct and presumably the duct of Wirsung were ruptured. There was positively no history of trauma in this case. Under free drainage the patient slowly but steadily recovered.

Histologically considered, the pancreas is a compound tubular gland, the branching ducts terminating in tubular acini. A small collection of secreting glands, held together by fibres of connective tissue, form a primary lobule. The grouping together of a number of primary lobules constitutes a secondary lobule, and a further grouping gives a large tertiary lobule, just discernible by the naked eye. The lobules are supported by connective tissue, both interlobular and intralobular. These are the secreting structures from which flow the digestive or external secretion of the pancreas, which is collected by the pancreatic duct and by it poured into the duodenum.

Langerhans, in 1869, described certain ovoid groups of cells, either distinctly or irregularly polygonal in shape, irregularly placed in the intralobular structures of the pancreas and having no connection whatsoever with the pancreatic duct or its radicles, nor possessing any form of excretory duct. These are the islands of Langerhans, which elaborate the internal secretion of the gland, which controls the metabolism of the carbohydrates.

Thus the pancreas is a dual gland, with two distinct and separate secreting structures, each elaborating its own peculiar secretion. While the external secretion is the most important and the most effective of the digestive fluids, its function may be carried on, under necessity resulting from pancreatic disease, by other digestive fluids and by the intestinal bacteria; but the internal secretion from the islands of Langerhans has, in the light of our present knowledge, no proven assistant, unless it be the glands of Brunner in the duodenum, and inhibiting or destructive disease of these insular structures at once results in an arrest of carbohydrate metabolism. If the contentions of certain recent investigators prove true, to the effect that lesion of the islands of Langerhans is the result, rather than the cause, of diabetes, then must we rewrite the pancreatic pathology of diabetes. For the purposes of this paper, the pancreatic origin of diabetes is accepted without prejudice to the claims of these recent writers.

Frequent and deliberate detailed study of the pathology of pancreatic disease is beset by many difficulties, chief among them being the fact that post-mortem changes, including an apparent autodigestion, occur with a rapidity so extreme as to preclude satisfactory pathological examination, either macroscopical or microscopical, at autopsy. It is due to the rapidity and the pronounced degree of these changes, indeed, that not only the nature of existing pancreatic disease has been misinterpreted, but also that its actual presence has been so generally overlooked in the routine post-mortem examinations in our large hospitals and public institutions. Mayo Robson, in referring to the rapidity of these changes, impressively says: "Only those who have seen and handled an inflamed pancreas can realize how an engorgement and swelling of the gland which was perfectly evident at the time of operation may, if the organ is examined a few hours later on the post-mortem table, have entirely disappeared, leaving a structure which is pale and flaccid, presenting, in fact, no marked deviation from the normal." It is from the surgeons, operating especially for gall-stones and the diseased conditions allied therewith, that the greater portion of our knowledge of pancreatic pathology in the human being has been obtained. Necessarily, the investigations of surgeons during the course of operations cannot be conducted with that thoroughness and deliberation attendant upon laboratory examinations, nor can sections of the pancreas be removed for subsequent microscopical examination, owing to the ulterior results arising from wounds of this organ.

In view of all these difficulties, our knowledge of pancreatic pathology is, as yet, considerably confused, and the literature of the subject contains many conflicting statements and theories. The one great fact of general acceptance, however, which stands out pre-eminently in this mass of confusion, is that practically all the important diseased conditions of the pancreas, including malignant disease, fatty degeneration, lesion of the islands of Langerhans resulting in intractable diabetes, true retention cysts, effusions into the lesser peritoneal cavity, profound and fatal intrapancreatic and extrapancreatic hemorrhages, and pancreatic calculi, are, in many instances at least, dependent upon a pre-existing pancreatitis, either acute or chronic, and that this causal pancreatitis is frequently associated with, and etiologically dependent upon, concretions within the biliary tract or the concomitant infection incident thereto or resulting therein.

Another point of decided surgical interest, concerning the occurrence of which there can be no differences for discussion, relates to the frequency, as yet scarcely appreciated, of hemorrhage, either mild or severe, into the substance of the pancreas, or immediately beneath the peritoneum on the anterior surface of the organ, resulting in a bulging encroachment upon the lesser peritoneal sac, or of hemorrhagic effusion into the lesser sac itself, these hemorrhages being incident to the course of a pancreatitis. The comparative ease with which the pancreas may be injured and hemorrhage provoked must constantly be borne in mind when operating upon structures adherent or contiguous to the pancreas, and particularly when exploring the distal extremity of the common bile-duct. This possibility of traumatic hemorrhage, as in that of spontaneous or non-traumatic hemorrhage, is considerably increased if pancreatitis, or malignant disease of the pancreas, either with or without jaundice of pancreatic origin, be present, owing to the marked urinary elimination of the lime salts of the blood in the course of a pancreatitis, materially interfering with and delaying the time of blood coagulation.

This tendency to hemorrhage in pancreatic disease is rather frequently shown in the occurrence of hemorrhage in the body structures apart and distant from the pancreas. One of my recent cases had many repeated hemorrhages into the skin, giving the appearance of severe contusions, a point which was of decided diagnostic value, as these petechial hemorrhages are by no means rare in the course of a pancreatitis. Moynihan observed, in one case of cancer of the head of the pancreas, severe and repeated hemorrhages from the bowel, and others have reported extreme and even fatal hemorrhages within the abdomen but apart from the pancreas, during a pancreatitis.

Pancreatitis can be provoked experimentally in animals by either chemical, mechanical, or bacterial agencies. In man, clinical observations but corroborate the deductions from animal experimentation, while the anatomical arrangement of structures brings into close relation with the pancreas not one only, but all, of the possible causal agencies. In the bile flowing through the common duct and, under favorable circumstances, liable to retrojection into the pancreatic duct, is found the chemical agent. The presence of gall-stones in the ampulla of Vater, or in the pancreatic portion of the common duct, exerting obstructive pressure upon the duct of Wirsung, affords the mechanical agent. The existence of bacteria in the ducts of Wirsung and of Santorini, in the common bile-duct and in the duodenum, all of which structures freely communicate, furnishes the third, which might well be called the explosive agent.

That the injection of bile or bile salts into the pancreatic duct in lower animals will cause an acute pancreatitis, has been conclusively shown by Opie and others. Flexner has carried these experiments further, demonstrating that the intensity of the pancreatic inflammation is dependent upon the concentration or dilution of the salts in the bile. Pure bile, undiluted by mucus, invariably produced an acute pancreatitis, while bile containing a large increment of mucus, as found in chronic inflammatory diseases of the bile tract, produced a chronic pancreatitis.

Opie reports the autopsy findings of a most interesting case of acute pancreatitis in man, in which a small gall-stone, lodged in the ampulla of Vater, while too small to obstruct the opening either of the common duct or of the duct of Wirsung into the ampulla, was still sufficiently large to obstruct completely the outlet of the ampulla into the duodenum. Bile, unable to escape from the ampulla into the duodenum, overcoming the intrapancreatic pressure, was retrojected into the pancreas through the duct of Wirsung, as was shown by the deep staining of the duct walls. In this case all conditions necessary to the production of an acute pancreatitis were present—the chemical irritant in the bile, the mechanical obstruction by the impacted gall-stone, the bacteria from pancreatic and bile-ducts powerful to infect the pent-up secretions and the tissues made less resistant by the pressure therefrom. That this peculiar form of obstruction cannot frequently occur is granted, yet the presence of a gall-stone in the ampulla, necessitating a transduodenal choledochotomy, is by no means rare, a number of such cases having come under my own observation; and it is fair to suppose that, while the majority will by pressure produce complete obstruction of the common duct, a small proportion will allow the reflux of bile into the pancreas.

Experimental obstruction of the pancreatic duct by ligature has repeatedly produced pancreatitis in animals, and we see the analogue in man in the cases of practically complete obstruction of the duct of Wirsung by a gall-stone lodged in the pancreatic portion of the common duct or in the ampulla of Vater; and it is this calculous obstruction which is, comparatively speaking, so frequently found associated with and productive of pancreatitis. Following the obstruction, an infection of the imprisoned fluids, of the structures of the duct, and, eventually, of the gland itself, ensues and continues as long as the obstruction remains.

When, as described in the early part of this paper, the common duct and the pancreatic duct unite to form a common channel some distance before opening into the duodenum, not only is the outflow of pancreatic fluid arrested by the impaction of a gall-stone in this common channel, but also the retrojection of bile into the pancreas is rendered unavoidable.

It is to Robson that we are indebted for the first exposition of the fact that pancreatitis is so frequently dependent upon cholelithiasis and so generally amenable to surgical treatment, primarily directed toward the gall-stones and the attendant cholangeitis. Recording his own experience, he states that he has found pancreatitis present in about 60 per cent. of the cases in which gall-stones were present in the common duct. The Mayos found 81 per cent. of their cases of pancreatic disease to be the result of or coincident with gall-stones. Deaver reports that the majority of his cases of chronic pancreatitis occurred in patients in whom no gall-stones were present at the time of operation, but in whom there were indubitable evidences of infection of the gall tract resulting in cholangeitis, cholecystitis, or pericholecystic adhesions.

It has been shown that, in an uncertain number of instances, the duct of Santorini opens by one extremity into the duodenum and by the other into the duct of Wirsung. Desjardins has proven that the duct of Santorini, when patent and normally situated and related, is but a tideway, the direction of the current through it changing from time to time, now flowing from the pancreas into the duodenum and again in a reverse direction from the duodenum into the duct of Wirsung and the pancreas. This reverse current carries with it bacteria from the duodenum through the head of the pancreas and pours them into the duct of Wirsung where, meeting the outbound current in that duct, they are returned to the duodenum by another route through the head of the pancreas. Infection of that portion of the pancreas lying in the triangle bounded by the two ducts and the duodenum is thus rendered possible.

Williams and Bush, basing the deduction upon anatomical study and experimental investigation, suggest "that some cases of acute pancreatitis may be caused by regurgitation of duodenal contents into the diverticulum of Vater, the way having been opened by the passage of gall-stones."

Maugaret contends that pancreatitis following cholelithiasis is not the result, either directly or indirectly, of an intestinal infection; that the infection does not invade the pancreas through the ducts, because of the bactericidal power of the pancreatic juice and the rapidity of the out-current in the ducts; that in very exceptional cases only does the infection extend to the pancreas by contiguity; that infection of the gall-bladder is the one constant condition in associated cholelithiasis and pancreatitis; and that infection is carried from the gall-bladder to the pancreas by the efferent lymphatics of the gall-bladder which terminate in the lymphatic glands at the head of the pancreas, which also receive the efferent lymphatics from the pancreas.

The interstitial changes occurring in the course of a chronic pancreatitis present two distinct types which, depending upon the relative location of the fibrosis, have been termed by Opie the interlobular and the interacinar. In the interlobular form of the disease the fibrosis, primarily between the lobules and not then affecting the intralobular structures, gradually extends inward from the periphery of the lobules. The affected portion of the gland is given a more distinct appearance of lobulation, and, because of the marked increase of connective tissue, it becomes decidedly enlarged and hard and unyielding to the touch. It is not until late in its progress that the morbid process involves the islands of Langerhans and diabetes supervenes.

The interacinar type is marked by the formation of a network of fibrous tissue within the lobules and surrounding the glandular acini. Involvement of the islands of Langerhans, with the resultant diabetes, is an early event in this form of pancreatitis. The interlobular structures are affected but slightly, if at all, and the affected portion of the pancreas does not usually become nodular, but remains uniformly smooth.

Because of the fact that 62 per cent. of the cases of cancer of the pancreas occur in the head of the organ, because cancer results in decided enlargement, distinct lobulation, and marked hardening of the glandular structures, and because surgeons have failed to recognize that in many instances the enlargement, lobulation, and hardening of the head of the gland was inflammatory, many cases of chronic pancreatitis of the interlobular type have been mistaken for cancer. Attention was first called to this point by Robson in 1900, and his contention has since been verified by a number of operators.

Blocking of the pancreatic duct by pancreatic calculi has been mentioned by some authors as a cause of pancreatitis. Reasoning from the premise that obstruction of the pancreatic duct will result in pancreatitis, this deduction would seem to be justifiable. However, Pende has shown that experimental aseptic ligation of the pancreatic duct will result in the formation of pancreatic calculi having the same chemical composition as the calculi found in man, while Galippe and Guidiceandra have demonstrated the presence of bacteria in pancreatic calculi. It would seem the more correct reasoning, to hold that a pancreatitis, of obstructive and bacterial origin, preceded and was the active factor in the formation of calculi; or that the development of a pancreatitis and the formation of calculi were synchronous phenomena resulting from the same cause; and that, in either event, the two conditions later became correlated, the obstruction and irritation of the ducts by the calculi still further aggravating the pancreatic inflammation.

That obstruction of the common bile-duct may occur without subsequently provoking a pancreatitis would seem, at first thought, to invalidate some of the contentions herein advanced. Reference, however, to the anatomical relations existing between the common bile-duct and the head of the pancreas, and to the relations between the common and pancreatic ducts, to the methods of termination of the ducts at their duodenal orifices, and to the functional importance of the duct of Santorini, at once explains this seeming discrepancy. As has been shown by Helly, the common duct lies in a groove, uncovered by pancreatic tissue, in 37.5 per cent. of individuals. Naturally, a gall-stone lodged in a common duct running in such a groove, exerting its pressure in the line of least resistance, would fail to compress a pancreatic duct embraced in the substance of the pancreas and, consequently, would not act as a mechanical cause of pancreatitis. When, as in the third and fourth divisions of Letulle's classification, the common duct and the pancreatic duct open into the duodenum by separate but adjacent orifices, a gall-stone obstructing the bile-duct could scarcely occlude by its pressure the pancreatic duct. Again, in a certain small proportion of cases, the duct of Santorini is the main excretory duct of the pancreas, while in others, although of secondary importance, the fact that it opens into the duodenum by one extremity and frequently anastomoses with the duct of Wirsung by the other, enables it to furnish an efficient outlet for the pancreatic fluid when the duct of Wirsung is compressed by a concretion in the common duct, and so annul the otherwise etiological power of obstruction of the latter. However, as the common duct runs through the head of the pancreas, being completely embraced by the gland, in 62.5 per cent. of all individuals, bringing it into close relation with the pancreatic duct, and as the common duct and the pancreatic duct open into a diverticulum of Vater in the majority of cases, the opportunities for obstruction of the pancreatic duct by gall-stones are indeed great.

As regards the etiology and pathology of retention cysts of the pancreas, the evacuation and drainage of which has to so large an extent constituted the pancreatic surgery of the past, some uncertainty still exists. The late Nicholas Senn advanced the reasonable hypothesis, that as intermittent and not permanent obstruction of the ureter resulted in hydronephrosis, so an intermittent obstruction of the pancreatic duct might produce a retention cyst of the pancreas. Cysts of the pancreas and pancreatic calculi are frequently found associated, but the association is not a correlation, as neither is etiologically dependent upon the other, but both are equally dependent upon a common underlying pathological condition. In the opinion of Robson, chronic pancreatitis is frequently and commonly this underlying condition.

The diagnosis of pancreatitis, either acute or chronic, is not difficult if advantage is taken of all the methods of diagnosis now available. Some of these essential diagnostic procedures are, however, laborious and time-consuming. In the past, difficulties arose because of the slight evidences of digestive disturbances in pancreatic disease, owing to the fact that other agencies were capable of taking on, to a large extent, the functions of the pancreatic fluid. Further difficulties arose from the almost universal association with pancreatitis of morbid processes in the bile tract, the stomach, or the duodenum, the symptoms of the associated processes being at times impossible of differentiation. At the present time, the information obtained from the physical, chemical, and microscopical examination of the fæces and urine, in addition to other signs and symptoms, makes possible the differentiation of the symptoms attributable to each of the associated processes and renders the diagnosis of an existing pancreatitis a certainty.

The digestive disturbances attending a pancreatitis are too indefinite to be of diagnostic value. Loss of appetite, with a particular distaste for meats and fats, is frequently noticed.

Vomiting is a common symptom in acute pancreatitis and an uncommon one in the chronic disease. The valuable symptoms arising from faulty digestion are found in the altered condition of the fæces. The fecal evacuations in pancreatic disease are frequent, soft, bulky, and pale. One of my patients had, regularly, from three to four large, soft evacuations daily. Patients will frequently complain of diarrhœa, but investigation will generally show that the term has been misapplied, it having been used because the stools were large, soft, and frequent. The importance of this symptom is greatly increased if jaundice is present. In cancer of the pancreas this symptom is not so common as in pancreatitis. In some instances, especially if the ingestion of fats is not diminished, the stools are distinctly greasy. The large size of the stool is the result of incomplete digestion, especially of albuminous foods. The frequency of the evacuations is due to their increased bulk. The normal pigmentation of the fæces being due to the presence of an insoluble pigment resulting from the action of the pancreatic juice upon some of the coloring matters of the bile, it necessarily follows that absence from the bowel of either pancreatic juice or bile will result in unpigmented fæces.

Azatorrhœa, or the presence in the fæces of a marked and unusual quantity of undigested muscle-fibres, is a valuable symptom in pancreatic disease, but is more strongly suggestive of malignant disease than of inflammation. While the undigested meat-fibres may occasionally be detected by the naked eye, a microscopical examination is generally necessary. In weighing the exact diagnostic value of azatorrhœa, the habits of the patient as regards the quantity of meats ingested must be taken into consideration, as undigested muscle-fibres can be found in the fæces of healthy individuals who habitually partake freely of meats.

Steatorrhœa, fat in the fæces, has long been recognized as a symptom of pancreatic disease and is a more trustworthy symptom than is azatorrhœa. Although in some cases of pancreatic disease the fæces are visibly greasy, the presence or absence of steatorrhœa must not be presumed, ordinarily, from the visual appearance of the stool, but must be determined by a thorough chemical examination. As confirmatory of the pancreatic origin of steatorrhœa, in any given case, the marked diminution in the quantity of fat in the stools following the administration of pancreatic extract is of considerable value.

In the presence of an enteritis, during which ingested materials are hurried through the intestines with more than normal rapidity, both azatorrhœa and steatorrhœa may be present with no pancreatic lesion. This possibility, as well as the habits of the patient as regards the ingestion of fats and meats must be given due weight in arriving at a diagnosis.

The existence of pancreatic disease having been established, the differential diagnosis between cancer and inflammation of the organ immediately assumes importance. Again, resort must be had to chemical examination of the fæces, for purposes of differentiation. In cancer of the head of the pancreas owing to the complete or nearly complete exclusion of the bile from the intestine, resulting from the obstructive gripping of the common bile-duct by the malignant growth, the fæces will be found free from or showing but the slightest trace of stercobilin. In obstruction of the common duct by gall-stone, or in swelling of the head of the gland in chronic pancreatitis, however, the obstruction to the outflow of bile is rarely either absolute or continuous, and stercobilin will be found in the fæces, although in diminished quantity.

Cammidge's pancreatic reaction when obtained in the urine is strongly, if not absolutely, confirmatory of the diagnosis of pancreatitis. No one symptom is so reliable as is this and, when considered in connection with the results obtained from examination of the fæces, it proves of inestimable value. It is, technically, somewhat difficult and tedious of performance, and technical errors must be absolutely excluded, as otherwise failure to obtain the reaction will result in an incorrect diagnosis. The technic of the test is too long and too complicated to warrant its presentation in this connection. While this reaction can be obtained in practically all cases of pancreatitis, it will be obtained, also, in about 25 per cent.

of the cases of cancer of the pancreas, owing to an associated pancreatitis. This possible error in diagnosis can be corrected by examination of the fæces for stercobilin, the absence of the latter in the presence of the pancreatic reaction indicating the existence of cancer of the pancreas.

Loss in weight, due to digestive disturbances and to derangements of internal metabolism, is a rather constant and important symptom of pancreatitis, yet it may not be marked or may be entirely absent. Taken in connection with other symptoms, this loss of weight is strongly confirmatory evidence of either inflammation or malignant disease. As would naturally be expected, it is present to a more marked degree in the latter.

Jaundice in the course of a pancreatitis may be of either biliary or pancreatic origin. The former results from obstruction of the common duct by stone without interference with the outflow of the pancreatic secretion. The latter, far more frequent than the former, may be occasioned by either a catarrhal pancreatitis so frequently resulting from a duodenal infection, or by compression of the common duct as it courses through the head of the pancreas, such compression being due to the enlargement of cancer or the swelling of inflammation.

Courvoisier's law that: "In cases of chronic jaundice due to blockage of the common duct a contraction of the gall-bladder signifies that the obstruction is due to stone; a dilatation of the gall-bladder, that the obstruction is due to other than stone," finds abundant proof in cases of pronounced pancreatic jaundice. That this law has been so distorted by some writers as to convey the impression that with dilatation of the gall-bladder the obstruction is due to cancer of the pancreas, is most misleading and unfortunate. The swelling of the head of the pancreas incident to pancreatitis can as surely result in obstruction of the common duct as can cancer. Moynihan, in this connection, says: "In several cases I have seen a chronic indurative pancreatitis produce jaundice with an enlarged gall-bladder." In one of my own recent cases of obstruction of the common duct from pancreatitis, the distended gall-bladder measured seven inches in length.

In those cases in which the common duct runs along a groove on the head of the pancreas, where it is comparatively free from compression, neither pancreatitis nor cancer will result in jaundice.

The decided tendency to hemorrhage in the course of pancreatic disease, already referred to, need not again be mentioned, except to emphasize its importance as a diagnostic measure.

Pain and tenderness may be pronounced in all the forms of pancreatitis, or they may be at all times absent. In acute pancreatitis both are well marked and the pain may be agonizing in character. The point of tenderness is from an inch to an inch and one-half above and to the right of the umbilicus. In hemorrhagic pancreatitis the pain is frequently of a colicky nature and paroxysmal in occurrence. Each paroxysm of colicky pain probably indicates an additional hemorrhage. In chronic pancreatitis, pain and tenderness are not so strongly in evidence but are generally present. In my own cases, I have never failed to elicit tenderness at the above-mentioned point; and some of my patients, when told to point out the exact seat of pain, have accurately outlined the location of the pancreas from the concavity of the duodenum to the spleen.

Only in exceptional cases have I been able to outline a tumor at the site of the head of the pancreas, although occasionally it can be done. In acute pancreatitis, especially in the hemorrhagic form, the tumor is generally palpable by gentle flat-hand examination. In one case, in which there was marked gastroptosis, at least two-thirds of the pancreas was easily palpable. In the chronic form of the disease, however, the definition of a tumor is always difficult and frequently impossible.

Inflammation of the pancreas may occur as a process limited to the pancreatic ducts or as one involving the parenchyma of the organ, the first frequently being but initiatory to the second. Inflammation of the ducts is observed as either an acute or chronic simple catarrhal inflammation which may, unless resolution takes place, terminate in the more active and dangerous form of suppurative catarrh of the ducts, or, by extension to the interstitial structures, eventuate in a chronic interlobular pancreatitis. Catarrh of the ducts may be caused by an infection from the duodenum in a duodenal or gastroduodenal catarrh, from extension by continuity of a similar catarrhal process from the bile-ducts, or from obstruction of the pancreatic duct by a peripatetic gall-stone temporarily lodged in the pancreatic portion of the duct. Unquestionably, in many instances, the jaundice so generally called catarrhal jaundice and so generally attributed to infection or obstruction of the bile-ducts by stone, is due to catarrhal inflammation of the pancreatic ducts, the swelling of the head of the pancreas resulting therefrom encroaching upon the common duct and interfering with, but not arresting, the outflow of bile.

Should this simple catarrhal condition result in the suppurative form, the bile-ducts become involved by continuity of structure and a suppurative cholangeitis supervenes. More frequently, the cause not being removed, the infection continues mildly active and, invading the deeper tissues, results in a chronic pancreatitis.

That a primary catarrh of the ducts and, later, a secondary chronic pancreatitis may occur from infection from the bile tract without obstruction of the common duct by stone, must not be forgotten. While, in the great majority of instances, chronic pancreatitis is occasioned by obstruction of the pancreatic duct from pressure by a gall-stone with an infection of the imprisoned fluids, this obstruction is not an etiological necessity. Gall-stones in any part of the biliary tract, causing a cholangeitis, may be responsible for the occurrence of a pancreatitis. These facts are well shown by Deaver's experience, which has been the experience of others, in that in the majority of his cases of chronic pancreatitis no stone was found in any portion of the bile tract, although inflammatory conditions resulting from the irritation of stones sometime present were plainly evident. In these cases a stone may have been temporarily lodged in the common duct, occluding by pressure the pancreatic duct sufficiently long to produce a pancreatitis mechanically which continued after dislodgment and escape of the impacted stone.

The parenchymatous inflammations may be either acute, subacute, or chronic. Acute pancreatitis is essentially a hemorrhagic pancreatitis. Gangrenous or diffusely suppurative changes may be engrafted upon the hemorrhagic process. Considerable discussion has taken place concerning the relative incidence of the hemorrhage and the inflammation. Some operators contend that hemorrhage precedes inflammation, others that hemorrhage follows and is but incidental to the inflammation, while still others, as does Robson, believe that hemorrhage may, in some ultra-acute cases, precede inflammation, while in others it follows. From an operative standpoint these points of discussion, while interesting, are of but minor importance.

The symptoms of acute hemorrhagic pancreatitis are those of acute peritonitis involving the upper abdomen, and may readily be mistaken for those of perforation of the stomach or duodenum or of rupture of the gall-bladder. Pain, sudden, severe, paroxysmal, and increased upon movement, limited, in the early stages at least, to the epigastric region, is present. Tenderness is marked in the midline and to the right thereof, just above the umbilicus. Rigidity of muscle was absent, as a rule, in Moynihan's cases, but Ochsner notes it as present in his cases, while it was well marked in my own. Faintness and collapse are early evident and are later followed by vomiting of food, bile, and altered blood. Constipation is present but is more apparent than real, as bowel evacuation and the passage of flatus can generally be secured following the administration of enemata. The pulse is rapid, the rate steadily increasing from the onset of symptoms, as pointed out by Moynihan. The temperature varies considerably in different cases, ranging from a point below normal to one several degrees above. Opie states that " fever is rarely present until secondary changes have occurred in the diseased gland," the inference being that the temperature is due to these changes rather than to the pancreatitis itself. Cammidge's pancreatic reaction can be obtained in the urine and may be the determining factor in a differential diagnosis. Moynihan says: "In two out of three cases upon which I have operated the most striking feature has been the general lividity of the skin; the face has looked suffused, the lips blue, and the body surface has been damp, cold, and leaden-hued." Opie and Ochsner have also observed cyanosis as a symptom, while Halsted has called attention to the cyanosis not only of the face but also of the abdominal wall.

A history of preceding attacks of gall-stone colic and a cholangeitis, attended in its later stages by jaundice, can almost invariably be obtained. This history taken together with the presenting symptoms makes a diagnosis of acute hemorrhagic pancreatitis strongly presumptive, and when Cammidge's pancreatic reaction is obtained, the diagnosis becomes positive.

Exploratory abdominal section is always indicated and must be performed early. In my own two cases of hemorrhagic pancreatitis a correct diagnosis was made in one case, and that of perforation of the duodenum from ulcer was made in the other. One, the first, was operated upon successfully, while the second died.

An uncertain number of cases of hemorrhagic pancreatitis are not attended by such pronounced and urgent symptoms, and they, naturally, offer a better prospect of success following surgical intervention. Collapse is not so marked, the pulse is neither so rapid nor so weak, nor does death ensue so quickly. These cases can well be classified as subacute.

The one great and essential feature in the surgical treatment of acute hemorrhagic pancreatitis is the provision for rapid, continuous, and abundant drainage. The method of approach to the pancreas must be determined by the conditions presenting when the abdomen is opened. The gastrohepatic omentum may be incised, as in my own cases, or entrance may be effected through the gastrocolic omentum. Approach through the mesocolon will scarcely ever be advisable because the subsequent drainage will be poor. Stab drainage in the costovertebral angle may be advisable, especially in the cases attended by suppuration. Ordinarily, the necessity for this procedure will be obviated by careful exclusion of the general peritoneal cavity by gauze swabs during the performance of the operation and the employment of abundant gauze drainage subsequently. Puncture or incision of the engorged pancreas may be employed to advantage, but the hemorrhage resulting therefrom will certainly be profuse and difficult of control. The incision in the pancreas may be packed with gauze held in place by catgut stitches or it may be closed by catgut stitches alone. Care must be exercised in the control of this hemorrhage by suture that the secretory ducts of the pancreas be not included in the suture, otherwise an obstructive element is at once introduced which must, necessarily, greatly complicate the subsequent course of the disease. The general treatment of hemorrhage, shock, collapse, and infection must follow the customary methods.

The pathology, etiology, and diagnosis of chronic pancreatitis, having been sufficiently considered in the early pages of this paper, will not require further mention. The treatment of chronic pancreatitis is the surgical removal of the cause or causes. Gall-stones residing in any portion of the biliary tract must be removed, and efficient drainage provided and maintained until the existing infection has disappeared.

Gall-stones lodged in the ampulla of Vater can be removed by the McBurney transduodenal choledochotomy. When lodged in the first or second portions of the common duct. direct incision of the duct must be chosen in preference to manipulation and attempted dislodgment of the stone. If the stone is impacted in the pancreatic portion of the duct it can be approached by mobilizing the duodenum, displacing it inward, and separating the loose connective tissue posterior to the head of the pancreas and lifting the latter forward. The discovery of one stone impacted in the duct does not preclude the presence of others, either in the ducts, the ampulla, or the gall-bladder, and most thorough exploration of the entire gall tract must be made in every instance.

Subsequent drainage of the biliary tract is essential to success. Whether this drainage is to be temporary or permanent will depend upon the degree of infection in the bile and pancreatic channels and the severity of the pancreatitis, as evidenced by the amount of swelling of the head of the pancreas and the degree of common-duct obstruction produced thereby. When the infection in the ducts is mild, when the swelling of the head of the pancreas is but slight, and when gall-stones are present, temporary drainage is indicated. This may be obtained by drainage of the gall-bladder by a cholecystostomy, or, when either the supraduodenal or the retroduodenal portions of the common duct have been incised for the removal of a calculus, by direct drainage of the duct by means of a rubber drainage tube carried into the duct and directed toward the liver.

In the majority of instances, however, especially when no calculi are found in any portion of the biliary tract, because of the uncertain length of time during which temporary drainage may persist, and because of the chronically persistent changes in the pancreas—changes which may not disappear and which are obstructive in their nature—permanent rather than temporary drainage must be provided. This is accomplished by the performance of a cholecystenterostomy or, more correctly speaking, a cholecystoduodenostomy, for the duodenum, rather than a lower portion of the bowel, should, whenever possible, be selected for the site of anastomosis. By anastomosing the gall-bladder with the duodenum the bile continues to be poured into the intestinal tract close to the outlet of the stomach, where the escaping stomach contents are early mixed therewith, as is nature's intention and provision. Of great subsequent importance is the fact that the danger of retrograde infection of the gall-bladder and ducts from the intestine is reduced to the minimum by selecting the duodenum as the site for anastomosis.

In the performance of any and of all of these operations the fact that the bile tract and its contents are highly infectious must never be forgotten. The peritoneal cavity must be especially well walled off by means of gauze pads. Before incising the gall-bladder it should be isolated from the surrounding structures by rubber tissue, as a dentist isolates a tooth. Abundant drainage will frequently be called for and can be assured by the employment of a split tube or tubes.

In conclusion, I would submit: That pancreatitis is of far more frequent occurrence than has been believed in the past; that it is a disease progressive in its nature and tending to a fatal termination; that it can, with the present methods at our command, be diagnosed without difficulty; that it is in the great majority of instances, secondary to, and dependent upon, cholelithiasis or infection of the biliary tract; that it can be cured, or its progress stayed, by the early removal of its causes and the prevention of their recurrence; that, its presence having been demonstrated, the immediate removal of its cause is imperative; that sodium phosphate, olive oil, neglect, delay, and optimistic indifference in the treatment of gall-stones must give way to prompt, radical, and efficient surgical intervention.

THE ADVANTAGE OF SIMPLICITY IN OPERATIONS FOR APPENDICITIS.

A REPORT BASED ON 110 CONSECUTIVE OPERATIONS WITHOUT MORTALITY.*

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Not many years ago the current teaching indicated that a "surgical procedure" was one which was done under the guidance of the eye, any operation not so done being characterized as "unsurgical." Since large wounds "heal as quickly as small ones," it was believed that the best results were to be obtained by making extensive dissections and inspecting the field of operation at each stage of its progress. This teaching, although sound in general principle, has been much modified: the appreciation of cleavage layers often obviates the necessity of extensive dissections, and patients have really been found to do best when the surgical procedure is thoroughly accomplished, with the minimum of tissue disturbance.

The surgical treatment of appendicitis was developed on the basis of the older teaching; it was believed that large incisions should be made, that the intestines should be walled back by gauze pads, that the entire appendical area should be inspected, that all possible local evidences of inflammation should be removed, and that the adjoining parts of the intestinal peritoneum should be treated with more or less vigor. The procedures have been simplified in general surgical practice so that the average appendicitis operation of to-day probably represents less than one-quarter the tissue disturbance which it did fifteen years ago. It would be difficult to enumerate the authors who have helped to effect this change, but Dr. Robert T. Morris of this city was surely a pioneer, and Drs. Hotchkiss, Stimson and Lilienthal have made contributions of very great value, while Drs. Murphy and Ochsner of Chicago, and the Drs. Mayo of Rochester, Minn., have emphasized and developed the details of the principle with the vast wealth of material at their disposal. In the very extensive literature which bears on the subject one can find an increasing tendency to trust the peritoneum to care for the moderate grades of inflammation which are at a distance from the appendix, and to relieve the local appendical inflammation in the simplest possible way.

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* Presented before the New York Surgical Society, May 12, 1909.

Since, however, there are still many surgeons who adhere more or less to the older method, the writer ventures to add another small contribution to the subject in recording the last 110 cases which have been operated upon in his service in the General Memorial Hospital, in St. Mary's Free Hospital for Children and in private practice. The series includes all the operations for appendicitis since September, 1907.

The tabulation was done by Dr. Charles E. Farr. Eighty-eight of the operations were done by the writer, seven by his associate, Dr. Mathews, and fifteen by other members of the assistant or house staff under the writer's personal supervision.

Patients are not included from whom practically normal appendices were removed in the course of operation for other conditions. In one sense, the series was a selected one; in another sense not. Owing to the character of the St. Mary's Hospital service, forty-four of the patients were under fifteen years of age. Owing to the character of the General Memorial Hospital service, patients were not sent there in the last stages of general peritonitis, as frequently happens in the larger general hospitals. Operation, however, in either of the hospitals or in private practice, was not refused to any applicant who had appendicitis. The series represents the cases as they came, without personal selection. There was no mortality among them; they all left the hospital or their sick beds in apparently good condition; their wounds were either completely healed at the time of discharge or were so healed soon afterward.

(June 21: Ten more cases have been operated upon without mortality, one too recently for prognosis, the others either in good health or in various stages of satisfactory convalescence. A patient who had left the hospital with her wound healed, and had enjoyed good health for three weeks after reaching home, developed febrile symptoms, without any symptoms of abdominal disease, and died—of pulmonary disease, the attending physician believes. This case is not counted as an operative mortality since both attending and consulting physicians have stated definitely that the symptoms were not abdominal but were pulmonary. She is referred to, however, as it is the writer's wish to represent the series exactly as it is.)

This freedom from mortality is not referred to as remarkable; many operators have had long series of similarly good results. The credit is largely due to the physicians who now so generally send the patients to the hospital before general peritonitis has been established.

The tables show that 24 cases were operated upon in the "interval," and that 22 were classed as chronic cases, having appendical constrictions, adhesions or other abnormalities which caused persistent symptoms. In the remaining 64 more acute cases the duration of time between the onset of symptoms and the operation has been tabulated as follows:

Operation in the first day	12 cases
Operation in the second day	16 cases
Operation in the third day	16 cases
Operation in the fourth day	2 cases
Operation in the fifth day	1 case
Operation in the sixth day	1 case
Operation in the seventh day	4 cases
Operation in the eighth day	5 cases
Operation in the tenth day	2 cases
Operation in the eleventh day	1 case
Operation in the twelfth day	3 cases
Operation in the twenty-third day	1 case

These patients were purulent in greater or less degree, some of them to a very great degree. It is particularly in their group that differences in surgical procedure exist and are important.

The method which has been used for them has been (1) removal of the appendix (if it could be easily reached) by the simplest available method; (2) drainage of the appendical site if pus was there; (3) neglect of the rest of the peritoneal cavity (excepting as the previously mentioned drainage opening provided an exit for its seropus during the first few hours after operation).

1. Under the first of these headings the following details of technic may be referred to: McBurney's incision placed well toward the side, so as to avoid unnecessary contact with the small intestine; size of incision, as small as will furnish satisfactory access to the appendical site, thus avoiding the intestinal exposure which so often accompanies large incisions; avoidance of pads, as far as possible, and use of broad retractors for holding back the intestines; following of longitudinal cæcal bands by aid of plain thumb forceps if appendix is not otherwise reached; separation of appendix from its bed of adhesions by fingers, often out of sight, sometimes aided by traction of aneurism needle passed through base of mesenteriolum; grasp of mesenteriolum by Ferguson clamp when possible, thus facilitating movement of, and access to, the cæcal end. The retractors can then usually be released and the appendix removed and its stump ligated and suitably treated within the walls of the incision and well away from the remainder of the peritoneum.

2. *Drainage.*—In providing for drainage of the appendical site, disturbance of the exudate which lines the abscess wall is avoided, the pus is simply taken up by gauze as it exudes. Soft rubber tubes, or gauze protected by rubber dam, are inserted and secured in position and a portion of the wound closed. Absorbent moist gauze dressings are changed twice daily for the first two days, then less frequently.

3. *General Peritoneum.*—The treatment of that portion of the peritoneum which is at a distance from the appendical site and certain other details may be best considered in referring to illustrative cases.

Case I.—*Localized abscess; much seropus in general abdominal cavity. Abscess drained; general abdomen disregarded:* C. S., æt. 13, admitted to hospital three days after the onset of a severe attack of acute appendicitis. Temperature, 104° ; pulse, 120; looked very ill and had much abdominal rigidity and a palpable mass in appendical region. Leucocyte count, 24,000; polynuclear, 90 per cent.

Incision was made well to the side and the opening of the peritoneum was followed by a gush of seropus. An abscess cavity was found in the cæcal region, which contained a ruptured appendix, concretions and thick foul-smelling pus. The appendix was enucleated from a mass of adhesions by the finger; its stump was ligated with catgut; gauze, protected by rubber tissue, was placed against it as a drain. A moist dressing was applied and she was returned to the ward without further procedure. Semi-erect posture and continuous saline rectal irrigation were used. Food was withheld for thirty-six hours, when a little broth was given. There was an abundant discharge of pus into the dressing and the wound was not entirely healed until five weeks later, but otherwise recovery was uneventful.

This represents a class of cases which has caused much confusion in the consideration of the subject, this confusion depending largely on the interpretation of the seropus (or cloudy serum) which lies free in the peritoneal cavity, and which gushes from the incision when the peritoneum is opened; it is usually almost white. Those who consider it highly infectious pus believe the case to be one of diffuse or general peritonitis, and they will surely find the intestines to be red if they handle them much. Those who believe that this seropus has very slight infective power will disregard it; they are accustomed to see serous effusions after various irritations, *e. g.*, strangulated hernia, early unruptured appendicitis; and know that it can contain many leucocytes without having much infective power, and they know that in cases with old encapsulated appendical abscesses it has largely disappeared. In this particular case, and in others which I have had examined, no culture grew from it. In this series of cases this seropus has been regularly disregarded, although it has often been present in large amount. General peritonitis has not followed in a single instance, and there has been only one secondary abscess to open.

The local abscess about the appendix is of course different. The pus here is usually highly infective, and every effort should be made to protect the general peritoneal cavity from its virulence.

The following case is also illustrative:

CASE II.—*Very long gangrenous appendix lying in middle of abdomen, with no apparent encapsulation. Profound sepsis; appendical tract drained; general abdomen disregarded.* C. S., æt. 51, admitted to General Memorial Hospital after two days of suffering from a very severe attack of gangrenous appendicitis, with severe pain, vomiting, chill and extreme prostration.

On operation the appendix was found to be six inches long, gangrenous throughout its entire length and containing four concretions; its tip lay to the left of the median line. In the patient's critical condition, the manipulation and cutting necessary to gain a complete exposure would surely have been fatal. On following the appendix with the finger, however, it was found to loosen, and was thus enucleated. Before the fingers were removed from the long tract where it had lain, cigarette drains were inserted to its end. The appendix was then removed after its base had been compressed and ligated and the stump cauterized and buried under a purse-string suture. No other treatment was given excepting the postoperative measures already referred to, and the recovery was prompt and uneventful.

There have been many of the severe cases similar to these two, and the prompt way in which they recovered when the appendix was treated in a very simple way, and the rest of the peritoneal cavity was disregarded, has made the writer very confident of the advantage of the method. The results have certainly been very much better than they were under the methods previously used.

The question of *appendix removal* is often an important one. The cases from whom it is not removed at the primary operation are illustrated by the following:

CASE III.—*Appendicitis of twelve days' duration; extensive peritonitis; much pus. Appendix not removed at primary opera-*

tion. E. H., a well-nourished child of 6 years, was brought to St. Mary's Hospital, February 27, 1908. Twelve days previously she had begun to have abdominal pain and to vomit. The vomiting had persisted and for the last few days she had been extremely ill, having much abdominal distention. On admission she presented the picture of extreme depression, with sordes on teeth, abdominal distention, rigidity and tenderness. Pulse, 120; temperature, 103°. Leucocytes, 68,000, 90 per cent. polynuclear.

Incision over the appendical region was made without delay. Much pus escaped. Such intestines as were seen were red, and there was much deposit of fibrin. No distinct abscess wall was evident. The examining finger could detect openings apparently to other parts of the abdomen. The appendix was not evident and no extended effort was made to find it. Her only chance of recovery manifestly lay in taking advantage of such adhesions as had already formed and relieving the site of maximum inflammation. Therefore, soft rubber tubes were simply put through the opening and a voluminous dressing applied. The operative procedure occupied hardly more than five minutes. She was returned to the ward and put in the Fowler position. Saline rectal irrigation was used. The dressings were changed twice daily at first. Food was withheld for twenty-four hours. Then, since she would not take broth, peptonized milk (half ounce, q. 2 h.) was given. During the process of healing sloughs or fibrinous coagula came through the wound, but she made a good recovery, excepting for a hernia, which was repaired in July, when the appendix was also removed.

There have been three cases in the series from whom the appendix was not removed. In work which preceded this series the writer has left it in several times and has had to remove it later in about one-third of the cases.

While considering the subject of protracted search for the appendix, the history of one of the patients of this group may be narrated. She had had a previous operation less than three years ago on the basis of the older teaching. The operation was done in a very good hospital, by an unusually good surgeon; the history was brought to me by the attending physician, and since location hides the identity of both hospital and surgeon, it is given in detail to show how radically a method of procedure, which was recently in general use and which is still in limited use, differs from the one here advocated.

The usual intermuscular incision, three inches long, was made through the abdominal wall, over the appendix, and the peritoneum opened. The cæcum was found presenting. To this the lower portion of the omentum was adherent, and the whole was bound tightly down with firm adhesions. These were broken up below and beneath the cæcum. A large abscess cavity, well walled off with firm adhesions and filled with thin, yellowish pus with foul odor, was found. The rest of the abdominal cavity having been previously walled off with pads, the pus was washed out with saline and the cavity sponged out. All the bleeding points were clamped and ligated and the contents of the abscess cavity examined. It was impossible to definitely identify the appendix, but a large necrotic and inflammatory mass, about the size of a large hen's egg and believed to contain the organ, was ligated and cut away. The lower portion of the omentum was likewise cut away and a drainage tube of rolled rubber dam was inserted down to the bottom of the abscess cavity. A split rubber tube with gauze wick was placed down to the iliac fossa and two accessory drains of gauze were placed beneath the cæcum. The wound was partially closed.

After the operation intravenous injection of salt solution was given and the temperature ranged around 103° until July 14, one week after the operation, when it touched normal. July 20, again arose to 103° and did not subside until July 25. July 31 a chill and temperature 103° once more, and at least twice the abdomen was searched for pus pockets. One pocket of pus in upper part of incision was found. Warm applications were applied q. 3 h. for several successive days at different periods. Temperature finally remained normal on August 8, and on the eighteenth the patient came home, the wound healing by granulation.

If the abscess had simply been opened and drained the extreme depression which made infusion necessary would certainly have been avoided. The extensive breaking up of adhesions, the use of fluid in the abscess cavity, the extensive exposure and wiping and the dissecting out of the egg-sized mass, were severe traumatisms and infection-spreading procedures. It is easy to believe that they were the cause of the extreme illness and the stormy and prolonged convalescence which followed. Furthermore, they accomplished no good purpose, as the appendix was left in after all and had to be removed at a subsequent operation. It is difficult to appreciate how a low mortality rate can follow this type of procedure.

AN IRRIGATING SOUND OF THE STANDARD AND BENIQUÉ TYPE.

ALSO AN IRRIGATING TUNNELLED AND GROOVED SOUND FOR THE DILATATION TREATMENT OF STRICTURE OF THE MALE URETHRA.*

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UNTOWARD results following the passage of sounds through the male urethra into the bladder are not by any means uncommon, even when there is neither stricture nor deformity of the passage, nor discoverable infection present. The uncertain manner in which the gonococcus lurks in the deep urethra, even after subjective and objective symptoms have disappeared, makes the danger of infecting the bladder the greatest of these unfavorable sequelæ. In a certain number of cases reflex nervous symptoms reaching even the limit of temporary anuria and of more or less severe urethral fever have been reported.

The writer has always had the feeling that the one surely safe procedure lies in filling the bladder with a warm mild antiseptic solution immediately after withdrawing the sound, which will provide against infection of the bladder, as previously stated, and will, by permitting the patient to evacuate this quantity of fluid, tend to correct the dangers of anuria and nervous chill. The antiseptic will furthermore protect against septic urethral fever.

For these reasons during many years the habit of the writer has been to follow the sound with a soft rubber or woven silk catheter by means of which the irrigation of the urethra and the bladder is accomplished. In addition to this, another detail of treatment has in the majority of cases been carried out, namely, to give sthenic patients morphine gr. ⅛–¼, fluid-extract of aconite mimims 2–3, and sulphate of quinine gr. 5–10. For asthenic individuals the medication is changed to codein gr. ½–1, nitroglycerin gr. $^{1}/_{100}$–$^{1}/_{50}$, quinine gr. 5–10. These are not "gunshot mixtures," far otherwise: the morphine or the codein allays nervous excitement; the aconite or the nitroglycerin dilates the blood-vessels, thus correcting congestion; and the quinine is an efficient febrifuge. After long experience with these combinations, the writer has still to find anything better for the purposes.

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* Read before the American Urological Association, June 7, 1909.

The passing of the catheter, however, has the objection of doubling the instrumentation, which is a decided disadvantage on account of the dangers of infection primarily and secondarily on account of the nervous irritation of the patient in cases, for example, where the sphincter of the bladder passes into slight spasm after withdrawal of the sound. In order to correct these features the writer devised an irrigating sound based primarily on the fact that in order to be readily aseptic the tube in the sound must be perfectly straight and have only end openings, so that a swab might be passed through it easily, if necessary.

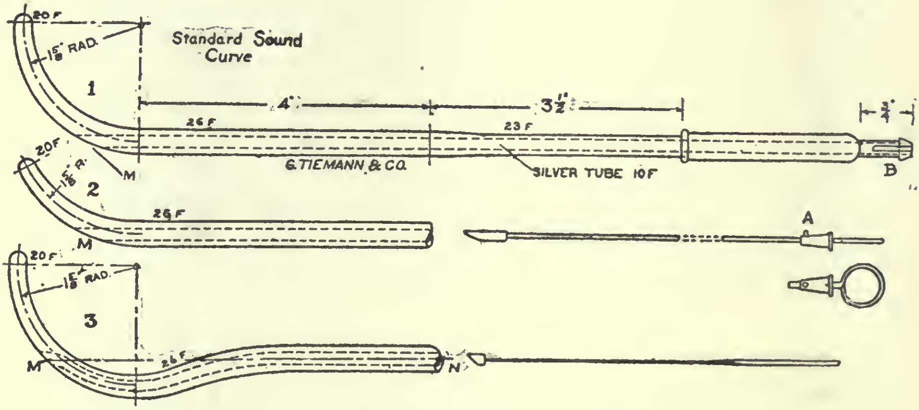
After considerable study and experimentation, a sound has been produced (see Fig. 1) which corresponds to the following description from No. 18 F. upward.

The irrigating tube is a silver catheter and is of the same size for the entire series, namely, 10 F. It runs straight through the shaft of the sound from the base of the curve to the nipple at the handle, at which it receives the rubber tube from the irrigator. At first sight this point of emergence at the base of the curve may seem to be incorrect, but actual practice with the sound shows that the necks of most bladders seize the sound just in front of the opening so that the irrigating fluid is delivered exactly where it is most required, namely, upon the floor of the bladder. In a few bladders it is necessary to push the sound in a little further, or to rotate its tip to the right or the left in order to disengage the opening of the tube from the mucous membrane, or to depress the handle of the sound in order to elevate the opening above the bladder floor.

The diameter of the silver catheter, 10 F., is amply large for evacuation of thick contents of the bladder and for irrigation of that viscus with due and normal rapidity.

As to the advantage of delivering the irrigation just within the neck of the bladder and directly upon the bladder floor, attention of the reader is drawn to the double-current irrigating instrument devised by Peterkin,[1] exhibited before the American Urological Association and described in the Transactions of that body, 1909. The instrument consists of the sheath of a cystoscope through which a tightly fitting partition is carried, borne upon a water-tight plug which fits the outer end of the sheath and itself carries one tube each into both halves of the sheath thus set off by the partition, and thus permitting inflow and outflow after the double-current method.

FIG. 1.



From above downward are shown the sounds with standard, shortened and Beniqué tips. The 6-size taper from straight shaft to point (26–20 F.) is indicated, also the 3-size reduction of Chetwood near the handle (26–23 F.) *M* points to the bladder outlet of the silver tube (10 F. diameter) and *B* to the hose-connection, identical for all sizes of the set. In the Beniqué instrument *M* shows the straight projection forward of the tube to open in the curve at a point just above the bladder floor. *A* illustrates the obturator. Note the position of the little plug far down the handle of *A*, to agree with the long slot in *B;* if the obturator is not properly seated in *B* the plug will not show at *M*, thus avoiding the accident of having the sharp point of the obturator project against the urethra and bladder, because this point is shorter than the slot in *B*.

The nipple is also of uniform size for the entire set and is tipped with a cone-shaped collar for rubber tubing ⅜ inch in diameter. This uniformity saves a great deal of trouble in making the connections, as this size of rubber tube is that commonly employed on irrigators and hand syringes.

The handle of the sounds is of the shell-like variety commonly seen on many instruments, and does not vary from sound to sound.

The shaft is of the double taper type introduced by Dr. Chetwood.[2] The first 3½ inches next to the handle are three sizes smaller than the main shaft, which then passes forward at full size for 4 inches until the base of the curve is reached, thus making the straight part of the shaft 7½ inches long.

The curve of the sound is on a radius of 1⅝ inches, which is the curve of the nonirrigating standard sound. The length of the curve is a trifle more than 90°, which is also the length of the curve of the nonirrigating standard sound. The taper of the curve is uniformly 6 sizes from the base to the tip, so that, for example, size 26 F. is 20 F. at the beak. In the writer's experience this taper is the most convenient. Some authorities prefer the standard curve but shorten it by about one inch.

Many other authorities prefer the Beniqué curve sound. In case sounds with the Beniqué tipe are to be used, I would suggest that the first 90 degrees of the instrument be tapered 6 sizes, so that, for example, a No. 26 F. instrument is 20 F. at the point. The tunnel should also pass along the curve until it emerges at a point corresponding with a straight line projected through the straight part of the shaft of the instrument until it cuts the curve. Thus a point of emergence is reached which will be just above the bladder floor when the sound is inserted exactly as in the other two forms. Although in the Beniqué sound the tunnel is no longer literally straight, in having only end-openings it may readily be cleansed. The obturator is of the same form as that just described excepting that the first few inches of the shaft are flexible, by being made of flat spring-metal.

The obturator of the sound consists of a small plug ground to fit the opening at the base of the curve of the sound accurately, mounted on a long rigid wire with a loop handle at the other end. A little metal plug fits into the lumen of the nipple, thus steadying the obturator at this point. In order to prevent the obturator from twisting, a device like a simplified bayonet-catch has been provided between the nipple and the handle of the obturator.

In order to prevent the sharp corner of the obturator seen in *A,* Fig. 1 (made by the obliquity of one surface where it matches the curve of the instrument), from projecting out of the silver tube and thus cutting the patient if it were to be placed in the inverted position in the tube of the instrument, the slot of the bayonet-catch in the nipple has been made very long and the plug on the handle of the obturator has been set forward a corresponding distance. Thus if the obturator is wrongly inserted the plug will prevent the obturator from being seated home at all until it is rotated so that the peg is in the slot.

When the obturator is set, in order to prevent any sharp edges whatsoever, the surface of the obturator has been *convexed* a little and the opening in the silver tube *concaved* a little, thereby preventing sharp edges.

These irrigating standard sounds have been in use by the writer and his colleague, Dr. Walter B. Brouner, for two years, having been devised in 1907.* The Beniqué and standard forms were shown before the Genito-urinary Section of the New York Academy of Medicine at its meeting in December, 1907.

The manner of using the sounds is as follows: After thoroughly boiling, the obturator is examined to see that it is freely movable for final withdrawal and then it is pushed into proper position and locked. The sound is then lubricated and introduced into the urethra in the usual manner. It is well to place the little finger through the loop in the handle of the obturator so as to be sure that the obturator does not slip. For the same reason it is also well to make the final pressure upon the sound by means of the obturator-handle, which is stout enough to permit thereof. After the sound has remained in place the desired five or ten minutes the obturator is gently withdrawn. Sometimes a flow of urine follows, especially if the sound has been left in the bladder five minutes or more. A receptacle should therefore be at hand to catch such evacuation.

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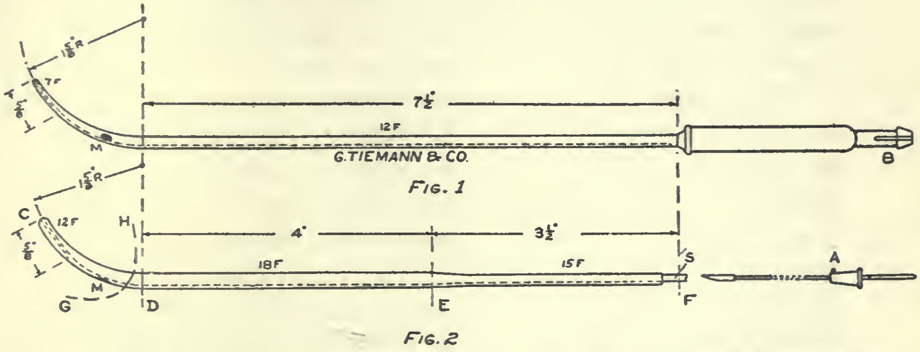
* The dates for the mechanical drawings for these sounds are as follows: irrigating sound, Beniqué curve, March 15, 1907; irrigating sound, standard curve, March 29, 1907; irrigating sound, short curve, December 21, 1907. The drawing for the tunnelled and grooved sound (subsequently described in this monograph) is dated January 27, 1908. This chronology may be of historical value later.

The irrigator, having previously been filled with the desired warm antiseptic fluid, is now connected to the nipple. The act of attaching the rubber tubing for the irrigator or syringe should be done so gently that chafing or scraping the bladder floor with the open end of the channel in the sound should not occur. In the writer's experience it is best for this purpose to have a three-inch piece of rubber tube of such size as to slip over the nipple very readily, but water-tight. Into this the conical tip of the syringe or irrigator may be slipped without disturbing the sound. Although apparently simple this is a very important detail.

FIG. 2.



Nos 7.8.9.10.11 12 are made of steel tubing, nickel plated opening on side in order to clear the groove (M, Fig. 1)
Nos 13 14.15.16.17.18.19.20, open on the convexity of the curve (M, Fig. 2)
Nos 8.9.10 11.12 taper to 7 at the end, in Nos 13.14,15.16 17 the taper is six numbers, uniformly (Fig. 1)
Only No 18 and larger are double tapered In a No "N" sound the curved portion i.e between C and D would increase from "N-6" at C to "N" at D, the portion between D and E is of uniform circumference, "N"; and the portion between E and F is also of uniform circumference but smaller i.e "N-3" (Fig 2)
In all sizes the diameter of tunnel and groove, the handle, and the rubber hose fitting are the same
No 13 and larger have a silver tube (S) which is the same in all sizes, 7 Fr (Fig. 2)
All the above numbers refer to the French scale

Under gentle pressure a few ounces of fluid at a time are run into and out of the bladder. If the flow does not immediately start it is probably due to the fact that the mucous membrane of the bladder floor lies too tightly against the bladder end of the tunnel. Rotation of the sound to right or left will correct this little difficulty. Or, the obstruction may be due to the fact that the sound is not in the bladder quite far enough, which is corrected by pushing it gently onward. If this is suspected, it is better to reintroduce the obturator because the oblique opening of the silver tube at the base of the curve makes the progress of the sound painful in these circumstances. After the bladder has been irrigated it is finally filled with the fluid and the sound without the obturator is withdrawn. The patient is then allowed to evacuate the antiseptic at once or to carry it away with him in his bladder for evacuation a quarter-hour or a half-hour later.

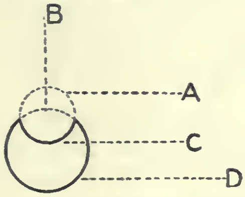
The results of using this sound seem to be emphatically not only a protection against all ordinary dangers of sound passing, but a distinct promotion of the comfort and reassurance to the patient. The writer has had, for example, a number of very intelligent patients who, although from the hands of well-known physicians, have stated that they never have felt so comfortable after the passing of a sound as they do after these irrigations and evacuations of a warm simple antiseptic fluid.

II. AN IRRIGATING TUNNELLED AND GROOVED SOUND FOR THE DILATATION TREATMENT OF STRICTURE OF THE MALE URETHRA.

Without entering into a lengthy discussion of the comparative merits in the treatment of stricture of the male urethra between the methods of dilatation and of internal and external urethrotomy, it is reasonably accurate to say that in the absence of inflammation of the urethra, bladder, and kidneys, which would indicate drainage, dilatation may be applied to most strictures of moderate extent along the length of the urethra through which a filiform guide may be passed. The tendency is to advocate the use of soft instruments in the early stages of dilatation until the halfway point (say 15 F.) has been reached. For the average practitioner this is certainly the safest rule; for the expert, however, who is always willing to be patient, gentle, and deliberate, rigid instruments are perfectly safe, provided that step by step (say every quarter-inch of advance) the freedom of the filiform guide in the tunnel is always proved by drawing out or pushing in the filiform a little. Many strictures which might require operation, thus taking the patient away from business, may be successfully dilated.

The necessity of always washing out the bladder and urethra after any instrumentation led the writer to devise an irrigating tunnelled and grooved sound laid down on the lines of the original Van Buren-Gouley sound. Hitherto the only irrigating instrument which might be used as a sound is the silver catheter, which unfortunately is so soft as to defeat its own purpose in no small number of cases. The writer has devised a tunnelled and grooved sound by taking two steel tubes for the small sizes and by cutting a segment out of the wall of each which when brazed together give the shaft of the sound, *D*, and the groove of the sound, *C* (see Fig. 3).

FIG. 3.



The dotted semicircle *A* indicates the waste of the small tube used to make the groove of the sound. The dark semicircle *C* shows the portion thereof comprising the groove. The dotted line *B* shows the waste of the larger tube cut away to accommodate *C*. The heavy line *D* represents the portion, which brazed together with *C*, makes up the cross-section of the sound.

The smallest size of the series is 7 F. These sizes are taken on the ground that if a stricture will not accept size 7 F. easily it had best be subjected to external urethrotomy, and on the ground that if the stricture accepts sound 7 F. it may be dilated to 8, 9, or 10 F. at the first sitting. It is to be remembered that the guide of the Maissonneuve urethrotome is 7 F. in diameter. This fact led the writer to determine upon the same size as the extreme small limit for the tips of his series of sounds.

In order to preserve the plan of the irrigating standard sounds just described, the curvature is uniformly of 1⅝ inches radius, the length of the curve is approximately 1 inch shorter than that of the standard sound. To compensate for this shortening of the tip the straight part of the shaft is elongated 1 inch. The taper of the curve is uniformly six French numbers in all sizes from 13 to 20. Sizes 8 to 12, both inclusive, however, taper to No. 7 at the point. By this plan of six-size taper where possible the dilatation is made very gradual. For example, size 18 F. is at the tip 12 F., at the middle of the curve 15 F., and at thirds of the distance between the tip and the middle of the curve 13 and 14 F., respectively, and at thirds of the distance between the midpoint and the straight shaft 16 and 17 F. respectively. Also, for example, size 10 F. is 7 F. at the tip and 8½ F. at the midpoint, and so on for the whole series of sounds. This careful uniformity of taper is of great service in using the sounds, for a stricture which has taken 8 F. will accept almost the half-beak of the 10 F. instrument before the real dilation begins, and a stricture which has taken 16 F. will engage almost two-thirds of the beak of an 18 F. sound before stretching ensues. Thus far greater safety in the use of the instruments is gained.

It is not necessary to have an office set consisting of all sizes. The author has found the even numbers sufficient, namely, 8 to 26 F., inclusive. Ordinarily No. 20 F. would be the largest required. Two patients, however, who refused urethrotomy had dense extensive strictures which required for safety the other numbers of the series stated, namely: 22, 24, and 26 F.

The shafts of the instrument are of uniform size from the base of the curve to the handle until size 18 F. and larger are reached. Then the double-taper plan of Chetwood is used.

The tunnels of the tips are of uniform diameter from the smallest to the largest sounds, namely, a trifle over the diameter of the ordinary whalebone filiform guide. This plan prevents wabbling of the larger sizes upon the filiform and accustoms the operator to a *uniform feel* of the action of the sounds in passing along the guides, also a very important detail. All tunnels are moreover ⅝ inch long, which gives relatively extensive cones for the tips of the sounds. The long-tunnelled tip follows the direction of the filiform better and really prevents the tendency of short tunnels to cut or buckle the filiform.

The grooves begin at the proximal ends of the tunnels and extend throughout the shaft to the handle and are likewise of uniform width and depth, *i.e.,* large enough to accommodate the standard filiform guide. This excess of space between the filiforms and the grooves is ample for the purposes of urethrotomy, namely, of guiding the knife and the director, should such be necessary.

Irrigation is provided for in sounds No. 13 F. and larger by silver catheters of uniform size (7 F.) extending from the base of the curve of the tip to the rubber hose-fitting in the handle and opening into the groove at the base of the curve. Sizes 7 to 12 (both inclusive) are hollow throughout and in order to clear the groove have the opening on the side also at the base of the curve. This is necessary because a separate silver tube could not be incorporated into such small sizes.

The handles of the sounds, including the hose-connections and the obturators of the sounds, are the duplicates of the types used in the standard sounds described in the first part of the article.

The extreme advantage of this type of irrigating tunnelled and grooved sound lies in the fact that it permits treatment of the bladder through the one and same instrument as is used to dilate the stricture. In other words, instrumentation is halved, *i.e.,* reduced to a minimum, which in most strictures is of extreme importance, because the reflexes due to irritation are matters of moment in all stricture-instrumentation.

In closing this paper it seems well to add a few paragraphs for description of similar sounds which have preceded those of the author. The following historical review, therefore, of dilating and irrigating sounds seems warranted.

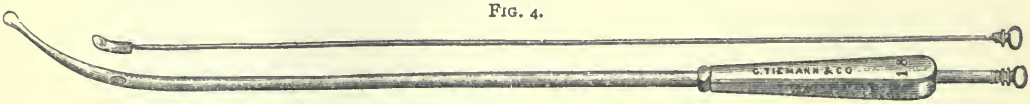
Syme's [3] guide appears to have been one of the earliest instruments for passing through stricture. It had no tunnel, but a long small curve shaped like an ordinary sound. The curve and first portion of the shaft were reduced to a small diameter and ended in a shoulder, whence proceeded a straight shaft to the handle. The shaft and tip were grooved as the guide to knife when operating. The tip, however, was so small that doubtless frequent accidents happened, due to the fact that the sharp point had no whalebone guide to make it clear the urethral walls.

G. Frank Lydston [4] says: "The late Professor W. H. Van Buren was the inventor of the first tunnelled instruments ever used and should have due credit for them." Gouley, however, seems to have been the first to describe the same. According to Van Buren and Keyes,[5] Gouley borrowed his idea from Van Buren. Without entering into a controversy long since passed, it will probably be good judgment to give both men credit and call the first type of tunneled instruments used the Van Buren-Gouley tunnelled and grooved sound, which was described by Gouley[6] in 1864. The original description reads: "It is a grooved conical steel sound with a canal one-eighth of an inch in length at the vesical extremity, and with a curve equal to one-fifth the circumference of a circle three and a quarter inches in diameter. The smallest (No. 3) is one and a half millimetres in diameter at the point. I have had larger ones (to No. 15) made to fully dilate strictures complicated with false passages, and have named them tunnelled sounds. When a capillary whalebone guide has passed through a tortuous or an eccentric stricture and has entered the bladder, the free end is slipped through the tunnel of the smallest sound, which is carried down to the obstacle, held in firm contact with it,—precaution being taken to keep the guide in the groove of the staff,—and in a few moments the instrument will pass, but no force or undue pressure should be used. It is desirable after having accomplished this much, to carry on dilatation rapidly, at the same sitting, to four or five higher numbers, to guard against the possibility of retention of urine from too great inflammatory swelling. The stricture should then be treated by gradual dilatation, and no other method thought of, unless dilatation fails after a thorough trial."

One feature of difference between the Van Buren-Gouley tunnelled instruments and those of the writer is that in the former the tunnels increase in diameter with the increase in the size of the sounds. In the opinion of the writer this is a mistake, because it deprives the operator of a uniform "feel" as to how the instrument is sliding over the filiform, duly provided for in the sounds of the writer by having all the tunnels of the same diameter and length.

Gouley's[7] catheter appeared about 1869 and is thus described: "In 1869 I adapted the tunnelled principle to the one-eyed English gum catheters and have used them with much satisfaction and success. The whalebone guide is passed through the vesical extremity of the instrument, which is open, and out of the eye. Their use is especially indicated when, after having made rapid dilatation of a narrow stricture, it is found necessary to retain a catheter for a few hours."

Fig. 4.



The Gouley[8] catheter staff appeared at about this time. It consisted of a silver tunnelled and grooved catheter with an obturator.

F. N. Otis's[9] dilating catheter was threaded from an opening in the end of the tube to the handle throughout the instrument.

L. B. Bangs's[10] instillating catheter sound was the next advance. It modified the Keys-Ultzmann syringe-sound so as to make the tips attach to the syringe-barrel by a slip-joint. Thus a set of tips comprising any series of sizes could be used. Through a small central tube from handle to tip irrigation of the bladder may be accomplished. The tube, however, is too small to permit the evacuation of thick bladder contents. The range of tips, however, in the set permits dilatation of the stricture and instillation of healing solutions upon the damaged mucous membrane to be practised with the greatest possible advantage.

About twelve years ago Dr. Willy Meyer[11] exhibited before the New York Academy of Medicine a sound reaching the indications for irrigation of the bladder and devised by Trendelenburg, of which the above is an illustration. It will be noted, however, that the Trendelenburg sound has an olivary tip, a peculiar, open, short curve, and lateral openings, thus, excepting in its purpose, it differs materially from the writer's sound.

This paper cannot be closed without giving credit to C. E. Panoff, M.D., for a sound described in the *New York Medical Journal* of June 12, 1909, in general terms closely like the sounds of the writer. Dr. Panoff states that the dates of the various models are July 23, 1908, Jan. 3, 1909, and May 17, 1909. It will thus be seen that the sounds of the writer were designed and in use more than a year previous to Panoff's.

In Panoff's sound the channel for irrigation is not a silver catheter and does not run through in a straight line to the base of the curve of the tip. The opening of the channel is inferiorly placed about three-quarters of an inch back from the base of the curve, thus requiring a deeper introduction into the bladder than do the sounds of the writer. The experience of Panoff, however, is identical with those who have used the sounds, namely, that the act of voiding artificial urine after instrumentation adds to the comfort of the patient. It is very interesting to see how two persons, unacquainted one with the other, working in the same specialty, should have reached much the same design of instrument independently one of the other.

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[2] Chetwood and Keyes: Venereal Diseases, 1900, p. 126.

[3] Truax, Charles: Mechanics of Surgery, 1899, p. 594.

[4] Bangs and Hardaway: An American Text-book of Genito-urinary Diseases and Syphilis and Diseases of the Skin, 1899, p. 176. G. Frank Lydston, "Organic Stricture."

[5] Van Buren and Keyes: Genito-urinary Diseases with Syphilis, 1874. Footnotes, pp. 127–129 (both inclusive).

[6] Gouley: Diseases of the Urinary Organs, 1873, p. 53.

[7] *Opus cit.*, p. 54.

[8] *Opus cit.*, p. 124.

[9] Otis, F. N.: Pamphlet 4741, N. Y. Academy of Medicine, p. 15. A Description of the Instruments and Apparatus of the Author with Directions for their use in Operations on the Genito-urinary Organs.

[10] Bangs and Hardaway: *Opus cit.*, 1899, p. 598. James Pedersen, "Impotence."

[11] Meyer, Willy: Roser's Sound and Trendelenburg's Catheter-Sound, N. Y. Medical Journal, 1892, vol. lvi, p. 162–163.

INTRAVENOUS LOCAL ANÆSTHESIA.

BY JAMES MORLEY HITZROT, M.D.,

OF NEW YORK CITY.

Before the 37th Congress of German Surgeons, in April, 1908, Bier (*Archiv. f. klin. Chir.,* Bd. lxxxvi, 1908, p. 1007) presented a method of local anæsthesia by the intravenous route which he had found extremely successful for the resection of joints, tendon transplantation, sequestrotomy, amputations of the various extremities, etc.

The method is applicable only to the extremities and briefly is as follows: The extremity to be operated upon is carefully bandaged with a soft rubber bandage from the distal end to a point sufficiently high to allow free access to the field of operation. This must be so done that all the blood is squeezed out of the extremity and kept out by a broad band above the field of operation. A second rubber bandage is wound about the extremity below the field of operation, enclosing it between the upper and lower bandages. Under infiltration anæsthesia a subcutaneous vein, close to the upper bandage, is exposed, if possible by a vertical incision,—if not, a transverse one will expose a vein without difficulty. The vein is freed, two ligatures passed beneath it, the upper ligature tied, and the vein cut across. An ordinary metal infusion cannula is then passed into the lower (distal) end of the vein and tied over it, firmly closing the vein about the cannula. Through this cannula the operator injects from 50 to 100 c.c. of 0.5 per cent. novocain solution in a direction opposite to the normal blood current. Anæsthesia results in from 5 to 10 minutes, due to the passage of the novocain solution through the vein wall, and is complete. The cannula is left *in situ;* injected solution must not escape.

When the operation is completed and before closing the wound, he washes out the veins with warm salt solution. As an additional precaution the upper rubber bandage is loosened sufficiently to allow the blood to flow through the arteries and thus to wash out still more of the novocain solution. After the blood has flowed for a few minutes the bandage is again tightened, the wound sponged dry, and closed in the ordinary manner. The dressing is applied and the rubber bandages removed. In amputations the line of the incision passing through the injected area makes the washing out process unnecessary.

The anæsthesia lasts for from 5 to 15 minutes after washing out the veins. In nervous individuals Bier finds a preliminary dose of morphine and scopolamine very satisfactory.

A number of cases suitable for this procedure, in which general anæsthesia was contraindicated or not desired, led me to try it; in each case anæsthesia was complete.

The armamentarium is very simple. A 0.5 per cent. novocain-salt solution is carefully sterilized by boiling. The implements necessary are a silver infusion cannula of the ordinary type, a piece of rubber catheter to connect this with the tip of a glass syringe of the type with asbestos packing known to the trade as the McElroy syringe, large enough to hold 100 c.c.

In applying the rubber bandage to the extremity it causes less discomfort if the main arterial circulation is cut off by digital pressure, the limb elevated, and the bandage then applied from below upward and fastened and the lower turns unrolled. As in an intravenous infusion, the cannula can be more easily placed in the vein if the two ligatures are held taut and a small longitudinal slit made in the vein between them. Into this the cannula may be readily slipped. The upper ligature is tied and the lower one tied carefully about the cannula to prevent leakage, as recommended by Bier.

As the solution is forced in, the subcutaneous veins become prominent and the solution can be seen entering the entire area between the bandages. After a few minutes the veins become less and less prominent and finally are not distinguishable, due to the rapid diffusion of the fluid into the tissues. The remaining steps are those carried out by Bier. The following cases are chosen to illustrate the efficacy of the above method:

CASE I.—*Amputation of Leg for Tuberculosis.*—Male; aged 28 years. Bellevue Hospital, service of Dr. Woolsey; operation February 1, 1909. Morphine, 1/8 gr., one-half hour and another 1/8 gr. fifteen minutes before time set for operation. After the usual preparation the femoral artery was compressed against the pubic ramus and the rubber bandages applied as above. The saphenous vein was exposed by infiltration anæsthesia, the ligatures passed, and the cannula inserted as described above; and 50 c.c. of 0.5 per cent. novocain solution were injected. In ten minutes anæsthesia was complete.

Anteroposterior flaps were made at the junction of the middle and upper thirds of the thigh and the skin flaps dissected back without the least pain to the patient. The muscles were divided down to the bone and pushed back sufficiently to allow for a high division of the bone. Throughout this step the only complaint by the patient was that he felt electric shocks in his leg, and when the sciatic was cut a shock twisted his big toe. The bone was sawed without any pain to the patient. The remaining steps, completed in the ordinary manner, were painless.

Throughout the patient's pulse ranged from 72 to 80, and on his return to the ward he enjoyed his midday meal. The day after the operation his temperature rose to 101° and then fell to normal on the fourth day, where it has remained. On the fourteenth day after the operation he was up in a chair for the first time in 14 months. The wound healed without unusual reaction.

Case II.—*Hallux Valgus.*—Woman; aged 44; was admitted to Bellevue Hospital (Dr. Woolsey's service) on January 20, 1909, complaining of pain over both great-toe joints. Both great-toe joints were swollen and reddened, the bursæ filled with fluid, and the toes abducted so that they rested across the other toes.

After the usual preparation the rubber bandage was rolled over the toes and foot to a point just above the ankle on the left side, and fastened there. A vein was exposed and about 30 c.c. of 0.25 per cent. cocaine solution injected. The solution could be readily seen entering the veins over the dorsum of the foot and anæsthesia was complete in one minute. The bursa was dissected out, a wedge-shaped piece of bone removed from behind the head of the first metatarsal, and the toe manipulated into position with absolutely no sensation on the part of the patient. Before closing the skin incision the veins were thoroughly flushed with warm salt solution and the tourniquet loosened as recommended by Bier. The wound was then closed, dressed, and the tourniquet removed. At the end of one hour the patient complained of severe pain in the foot, which she described as tingling or burning in character, as "if it had been frost-bitten." Three hours after the operation the patient had a shaking chill and said she felt sick and nauseated, but was relieved by ⅛ grain of morphine hypodermically. Her temperature rose to 102.5° F. and then gradually fell to normal. The wound healed kindly except at one point, where the skin became a little blue and looked doubtful and a stitch was removed, after which it granulated in rapidly.

Her sole complaint throughout was that the rubber bandage at the ankle was too tight, a just complaint, as I believe we had wrapped it with too much earnestness in our zeal to render the foot bloodless.

CASE III.—*Tuberculous Tenosynovitis of the Extensor Tendon Sheath of the Arm.*—Man; 35 years of age. The process involved the extensor tendon sheath from the level of the ulnar styloid about six inches up the arm, and was filled with small movable bodies.

After freeing the forearm of blood by compressing the bracheal and elevating the arm, the rubber bandage was applied from below upwards and fastened just above the elbow. A large vein on the ulnar side of the arm which had been previously selected was exposed under cocaine infiltration, the cannula inserted and 50 c.c. of 0.5 per cent. and 50 c.c. of 0.25 per cent. novocain-salt solution injected. Anæsthesia was complete in 15 minutes and the man, a rather stolid individual, watched the skin incision, saying that he had no pain although he saw me cutting. The tendon sheath was opened and dissected out, the wound wiped with the iodine-glycerine solution of Durante, and the tissues loosely closed over the tendons. The veins were flushed in the usual manner, a few bleeding points caught and tied, and the skin closed with two small rubber-tissue drains at each angle. He had no constitutional reaction.

From my experience novocain is the ideal anæsthetic for this method. Cocaine in the one case in which it was used gave a marked constitutional reaction, and although its action was more rapid the likelihood of dangerous symptoms is so much greater that it has nothing to commend its use.

Its superiority to infiltration anæsthesia for the types to which it (intravenous) is adapted is most marked. It is simpler, more rapid, and more complete, and will supplant the slower method in many cases.

A MODIFICATION OF THE CRILE TRANSFUSION CANNULA

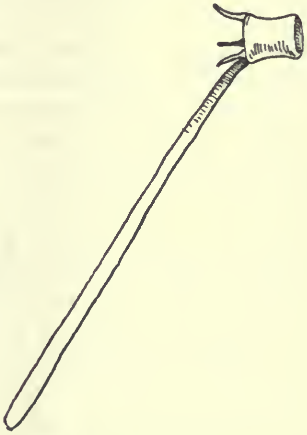
BY BERTRAM M. BERNHEIM, M.D.,

OF BALTIMORE, MD.

From the Hunterian Laboratory of Experimental Medicine, The Johns Hopkins University.

THE instrument (Fig. 1) consists of a hollow tube 3 mm. long, having three rounded, sharp-pointed hooks on one end. These hooks are 2 mm. long, are placed at equidistant points around the lumen and flare outward just a bit at their tips. Between two of the hooks is the handle, which comes out in the same direction as the hooks, but, in addition to being much thicker, the handle is 2½ cm. long and is flattened a little so as to be easily held. The cannulæ are made in four sizes, referring to the bore, 1½ mm., 1¾ mm., 2 mm., and 2¼ mm.

FIG. 1.



The three-pronged cannula.

The technic[1] of the transfusion is in most respects similar to that used for the Crile cannula. The vein of the donee is carefully isolated and, after being tied off distally and secured proximally by a bull-dog clamp, is divided, leaving about 3 cm. free for manipulation. The lumen of the vessel is thoroughly washed out with warm saline, followed by liquid vaseline, after which all superfluous adventitia is removed. The artery of the donor is prepared in a similar manner.

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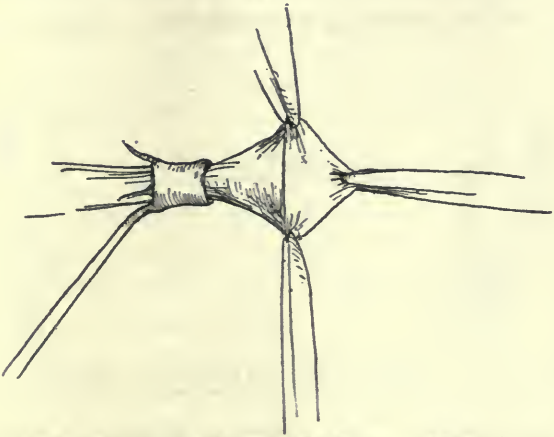
[1] Crile: ANNALS OF SURGERY, September, 1907.

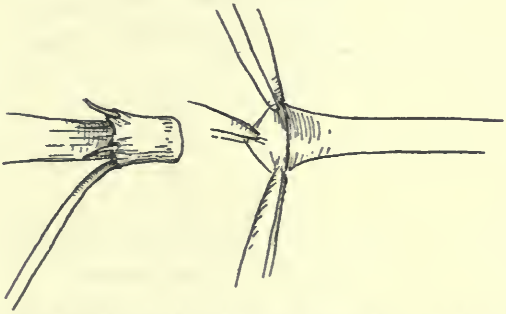
FIG. 2.



The vein drawn through the cannula and about to be everted over it.

The vein is then, by means of a needle and thread, passed through the cannula[2] (Fig. 2), hook end first, grasped by mosquito clamps at three equidistant points along its lumen, everted over the cannula and impaled on the three hooks

FIG. 3.



The vein passed through the cannula and everted over it, ready to receive the artery about to be drawn over it.

(Fig. 3). Next, the artery is seized in a similar manner by three mosquito clamps and, after being gently dilated, according to the suggestion of Crile, by the end of a clamp previously dipped in sterilized oil, is gently pulled over the cannula with its everted vein and also impaled on the three hooks. A tie is now placed around the cannula (Fig. 4), for the sake of greater security, and the blood allowed to flow, the clamp on the vein being removed before that on the artery (Fig. 5).

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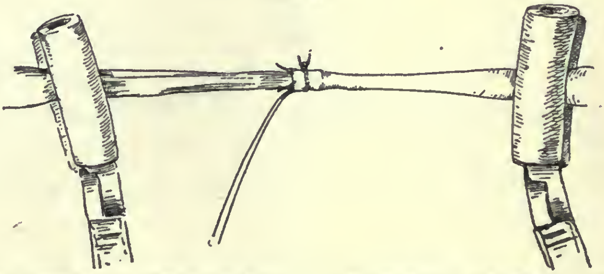
[2] The size of the cannula selected should be judged by the actual tissue thickness of the collapsed vein which is to be passed through it.

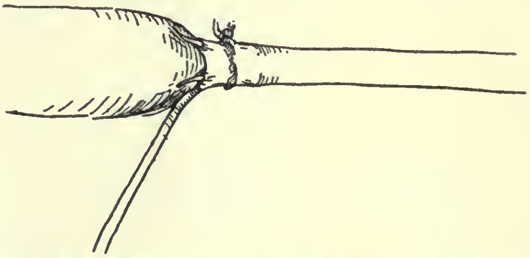
FIG. 4.



The communication between the artery and vein perfected; clamps still in place compressing the respective vessels.

The advantage of this over the ordinary Crile cannula is that it is absolutely unnecessary to hold either vessel while the tie is being placed around the cannula. This difficulty, slight as it may seem, is often a most serious drawback to the successful performance of a transfusion.[3] As a matter of fact, if the artery has not been too much dilated before being impaled on the hooks of our cannula, no tie at all will be necessary, as there will be enough pull on the artery and vein to prevent leakage. As a routine, however, we think it best to put one tie around the cannula and vessels.

FIG. 5.



The artery and vein as finally secured together, and the flow of blood going on.

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[3] Hepburn: ANNALS OF SURGERY, January, 1909.

THE "OPEN-SEAT" PELVIC BINDER.

A PRACTICAL BANDAGE FOR OPERATIONS ON THE SCROTUM AND TESTES AND ILIO-INGUINAL REGION.

BY SAMUEL E. NEWMAN, M.D.,
OF ST. LOUIS, MO.

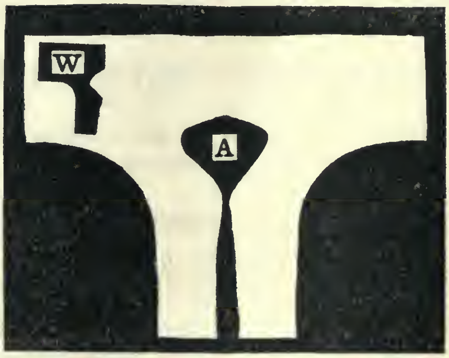
OPERATIONS about the scrotum and inguinal regions have been greatly improved and the results are not comparable with those of antecedent years. But it usually provokes strong comment to see the bandage applied after an almost technically perfect operation. To say the bandaging is crude, puts it lightly; and I therefore do not think my paper needs an excuse.

No part of the body seems more difficult to bandage properly than the scrotum, and probably none is so grateful for small attentions. The scrotum should neither hang like a bag nor be squeezed between the legs. Postoperative comfort is greatly augmented by supporting the part in a high posture. If this position, which is much desired and seldom obtained, can be secured there is less likelihood of venous oozing and serous effusion into the sack; the tension on the stitches is reduced to a minimum and primary union made more certain. Sometimes it seems as if the success of the surgical procedure is frustrated by the lack of proper support and protection of the part.

The convenience which the "open-seat" offers to both patient and nurse is of real importance, and no word of mine is necessary to point out the desirability of this special feature.

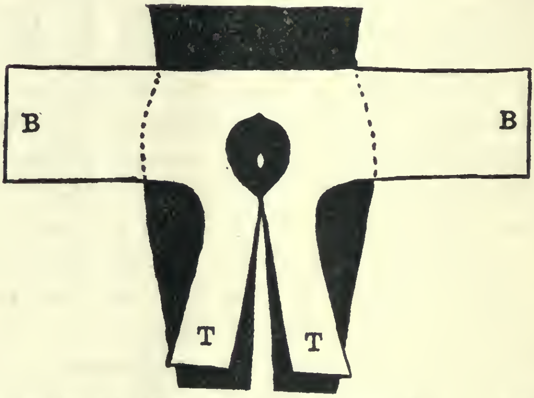
Material.—The full width of unbleached muslin is used; for the small size one and one-quarter yards, and for a large size one and three-quarter yards are sufficient. Two sizes will accommodate the usual run of cases. The material shrinks after washing and it is best to use a shrunken muslin for the bandage if it is to be laundered and re-applied. One

FIG. 1.



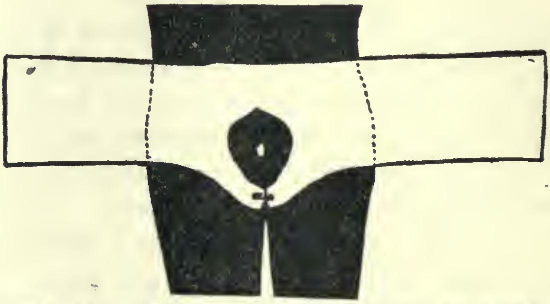
Cutting out the bandage. Fold the length of the material on itself, once. Cut the muslin as indicated at *W*. Open the doubled muslin and the resulting pattern should be Figure 1, a two-tailed binder cut out at *A* for the anal opening.

FIG. 2.



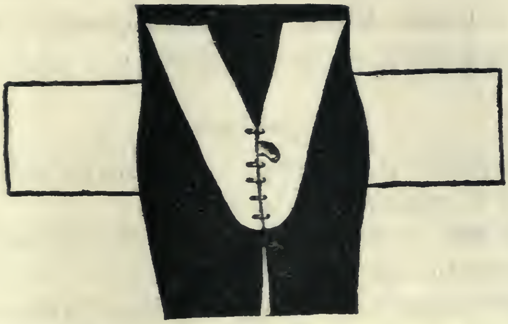
Applying the bandage, posterior view. The bandage is put in position so that the rectal opening is in the center of the bandage. The abdominal ends, *B*, *B*, are brought out to either side of the patient. The perineal tails, *T*, *T*, are under the thighs ready to be brought forward between the legs.

FIG. 3.



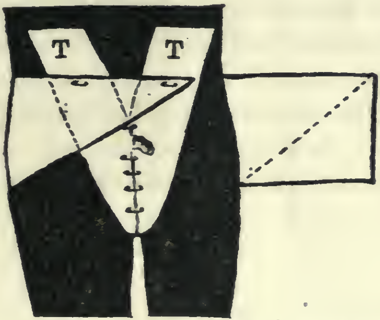
Posterior view. The two tails are brought forward between the legs and a safety-pin locks the two sides over the perineum.

FIG. 4.



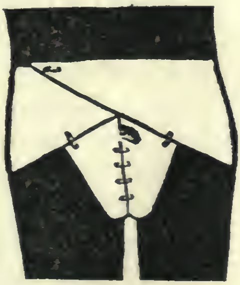
Anterior view. From below upward the two tails are joined with a few safety-pins. A high opening is left for the penis. Very material assistance is gained if someone pulls on the tails while the pins are being inserted.

FIG. 5.



One side of the abdominal binder is folded into a triangle, brought across the abdomen and fastened. The other side is treated in the same way and any excess of material, *T*, *T'* is turned under.

FIG. 6.



The completed bandage. From below, where the bandage is open, push in a good quantity of cotton to bolster up the scrotum. This raises the part to a high position and protects the wound from contamination.

thickness of the material may be enough, but the binder is stronger and more lasting if it is composed of two layers and the edges nicely stitched together.

ADVANTAGES.

1. The patient is not lifted; turning on the side is all that is required in applying the bandage.
2. It is held in place by the spines of the iliac bones and does not tend to slip.
3. The scrotum is not merely supported between the thighs but rests on the pubes.
4. Urination is not interfered with.
5. Easy access to the rectum; defecation does not necessitate a change of the bandage.
6. The bandage does not become stringy and see-saw the skin of the entire region.
7. Inspection of the wound is easy and requires little more than the removal of a few safety-pins.
8. After dressing the wound the same bandage may be re-applied; if the binder is soiled, it is laundered and re-used.

NOTE ON SILVER FOIL IN SURGERY.

BY JOSEPH S. LEWIS, M.D.,

Intern at the German Hospital in the City of New York.

It is a repetition, but surely not a vain one, to assert the value of silver foil as a surgical dressing. Its use has become firmly established in some hospitals while disregarded or unknown in others.

Following the work of Müller (1899) and Naegli (1893), to which he refers, Bolton[1] in 1894 demonstrated the inhibitive and bactericidal action of various metals. Halsted,[2] founding the practical use of silver foil on the laboratory work of Bolton, introduced it into the wards of the Johns Hopkins Hospital in 1895.[3] Since then the use of silver foil dressing has been propagated largely by such as have seen it used in Baltimore.

In 1896 Credé[4] published his observations on the mode of action of silver and its compounds, his work resulting in a flood of literature which carried numerous silver compounds into general use. On the compounds we have nothing to add.

Metallic silver as an aseptic dressing derives its value chiefly from its bacterio-inhibitive power, sufficient to check bacterial growth but not to alter the normal process of repair in the adjacent healthy tissues. The foil is therefore in harmony with the practice of asepsis in this sense, that it does not destroy living somatic cells. As demonstrated by Credé, the dressing lies in contact with a clean open wound without change, but in the presence of growing bacteria the lactate is formed, wherein the inhibitive power has been found to reside. The bactericidal power of the lactate in stronger solutions is markedly less than Credé was at first led to believe[5]; and this is doubtless fortunate, for were it bactericidal in the proportion 1 to 80,000, as first stated, it must, barring selective action, surely kill body-cell with bacterium.

In practice silver foil has been found to do no harm, thus fulfilling the first desideratum of all therapeutic measures. This is the general experience,[6, 7] as well as our own at the German Hospital. Our conclusions are based on its routine use during the past four months on upwards of 200 unselected cases with especial observations of about 100 of these. That it is harmless does, of course, not alter the fact that it is of little or no value on certain wounds, as, for instance, chronic granulating surfaces. It cannot reach bacteria growing in such granulations, and the sheets are prone to incorporate with the dried pus of profusely discharging wounds and rise from contact with the surface.

Of what use then is the foil? The following advantages have been demonstrated in the order stated:

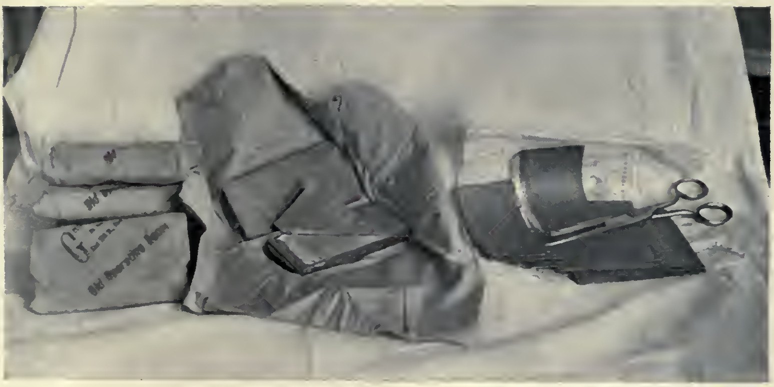
1. On clean skin grafts the dressing is at its best and has replaced the older methods of wet dressings and gutta-percha, or the dry gauze dressings which present mechanical drawbacks. The unguents are either too active if antiseptic, or favor bacterial growth, or amount to occlusive macerating dressings like gutta-percha. Under the foil the grafted skin remains fairly dry, as is the condition of normal skin. One clean graft under silver was observed to have taken firmly on the third day after operation. Others were not inspected until the expiration of a week or more.

2. In plastic surgery where cosmetic results are desirable, the slight secretion along the linear wounds passes through the crevices in the foil to be absorbed by the superimposed gauze, minimizing scab formation. This was demonstrated in control dressings in which one half of a wound was covered with gauze and the other with silver.

3. In the usual clean wounds the possibility of infection from without is made more remote, especially in the groin, where the dressing may become wet with urine or slip and so expose the wound. In clean wounds near a discharging one, as in some secondary operations, the clean one may be protected against the other until union is established.

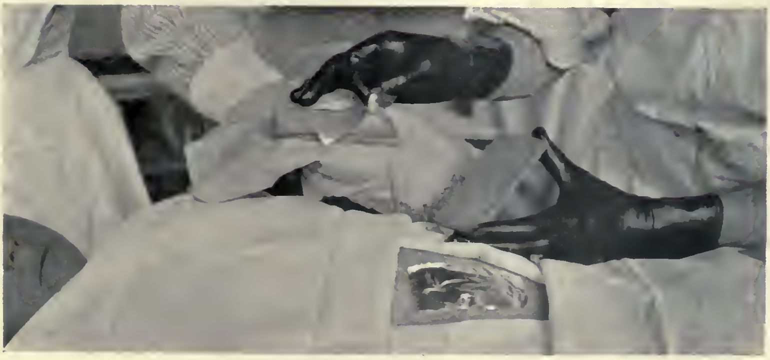
4. Though we have used it in only one such case and that

FIG. 1.



The cut leaves are placed between boards to be sterilized.

FIG. 2.



Manner of manipulating the silver leaves.

too recently to add the ultimate results, the foil may be recommended on theoretical grounds to prevent subdural adhesions, for which we refer to an article by Harris[8] for practical demonstration.

5. In clean rapidly granulating open wounds, the foil protects the delicate advancing margin of epithelium. Chronic ulcers such as the varicose type are not benefited. In two cases it was found suitable in burns after the acute stage was passed, but of no preference over other methods. In the acute or painful stage of burns it is useless.

Silver foil is no longer at a disadvantage as regards its cost, in that it may now be had for one-fifth the price quoted as reasonable by Hagner[6] in 1901. One dollar a month more than pays for all the foil that is used in this hospital.

The following method of preparation and use is essentially that of Halsted, save that we deviate from the use of paper over the foil, as favoring retention beneath the dressing of the slight postoperative bleeding or exudation of serum. The gauze is placed directly on the foil through the breaks or cracks of which the fluids find their way. Where the gauze adheres to a graft it may be removed by the usual methods, though if bleeding has been absolutely stopped this does not occur.

The leaves are cut and placed between non-resinous boards of one-half inch or greater dimensions, and put into packages with squares of sheeting (Fig. 1). At the hospital, sterilization is accomplished in the autoclave. For the office a cover of wrapping paper or old sheeting protects the packages, to be baked in the oven for 15 minutes or until the paper is slightly scorched.

In handling the foil for dressings, too great nicety means loss of time and temper. The papers, not the silver leaves, are seized with damp fingers while the silver, which for the moment adheres to the paper, is placed on the wound (Fig. 2).

We are convinced that silver foil should be a familiar surgical dressing in every well-regulated hospital.

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TRANSACTIONS
OF THE
NEW YORK SURGICAL SOCIETY.

Stated Meeting, May 12, 1909.

The President, Dr. Joseph A. Blake, in the Chair.

ENUCLEATION OF THE TONSILS.

Dr. Frank S. Mathews presented a number of children whose tonsils he had removed by the finger-enucleation method. In one of the cases the operation was done a year ago; in another, only a week ago.

The cases were shown in order to illustrate the fact that by this method surgeons are less likely to injure the wall of the pharynx than by the methods in which knives, scissors and dissectors are used and the normal architecture of the pharynx may be interfered with. After complete enucleation of the tonsil the wound healed as well and even better than after tonsillotomy, and cicatrization, the result of injuring the pillars and which was apt to draw the uvula to one side, was absent.

In addition to the patients, Dr. Mathews showed a number of tonsils that had been removed by this method.

URETERAL CALCULUS IN A CHILD: TRANSPERITONEAL AND RETROPERITONEAL REMOVAL.

Dr. John F. Erdman presented a child, 7 years old, who had been the subject of impacted calculus in the right ureter, directly over the spine of the ischium. The patient's symptoms dated back for three years, consisting chiefly of hæmaturia and pain simulating appendicitis. The child was X-rayed three different times, each picture showing a ring of shadow in the course of the right ureter over the spine of the ischium. The ureter was reached without much difficulty through a transperitoneal retroperitoneal incision, and the calculus was removed. The child's convalescence was uneventful, the wound healing in the course of two weeks.

NEPHRECTOMY FOR TUBERCULOSIS OF THE KIDNEY.

Dr. Benjamin T. Tilton presented a kidney, together with the person from whom it had been removed. The patient was a girl of 18 years, who up to a year and a half ago had been well with the exception of an attack of smallpox at the age of 6. There was no family history of tuberculosis or renal disease. Eighteen months ago she began to have pain in the right loin, accompanied by frequent and painful micturition. She never noted anything abnormal in the character of the urine. Three months later she was operated on at another hospital, an incision being made in the right loin, and pus evacuated. She remained in the hospital for three months and left with a discharging sinus. From that time up to February 2 last (about 16 months) she complained of nothing excepting the discharging sinus, for the relief of which she came to the hospital.

Examination at this time showed an anæmic but fairly well nourished young woman. Heart and lungs were negative. In the region of the right kidney a good-sized mass was easily made out by palpation, and was somewhat tender. Posteriorly, a sinus discharged a moderate amount of pus. The edges of the sinus were pale and flabby. The patient's temperature ranged from normal up to 100.8. The urine was clear; specific gravity, 1010; urea, 1.6 per cent. It contained no albumin, and microscopically a few epithelial cells.

Cystoscopic examination showed a healthy bladder, with no signs of cystitis. The right ureteral orifice was contracted, and no urine flowed from it. The left ureteral orifice was normal in appearance, and clear urine issued from it.

A diagnosis was made of tuberculosis of the right kidney, with occlusion of the right ureter, and a healthy left kidney. Nephrectomy was decided upon. Thinking that the first operation had been a nephrotomy, Dr. Tilton said he anticipated a great deal of difficulty in removing the kidney in the presence of dense adhesions to the surrounding structures. To his great surprise, upon cutting down upon the kidney, he found that it shelled out with the greatest ease, there being only the thinnest adhesions with the surroundings. This was accounted for by the fact that the kidney had not been opened at the first operation, but merely a perinephritic abscess incised and drained. The primary source of the abscess, namely, the tubercular kidney, had been left intact, and therefore had not become the seat of secondary pyogenic infection with resulting adhesions to the surrounding parts.

The ureter was exposed for several inches, and tied separately from the vessels. Chromic gut was used for both ligatures. The patient reacted well from the operation, and made an excellent recovery. She had gained about ten pounds in weight since the operation, which was done a little over two months ago. The sinus had not entirely healed, but the discharge was very slight.

The specimen showed a caseous degeneration of the entire kidney, with liquefaction in some portions. There was found a minute communication between the interior of the organ and the sinus, which accounted for the persistent discharge from the fistula in the loin.

Dr. Tilton said the case demonstrated the possible origin of a perinephritic abscess from a tubercular kidney, and the incompleteness of the result of simple incision of such an abscess. Whether or not it was desirable in every case of perinephritic abscess to examine the kidney at the time of operation was probably a matter of individual judgment. If, however, there was a distinct history of renal symptoms, it would seem a wise course. In this particular instance such an examination would have led to the discovery of tubercular disease of that organ, and a nephrectomy would have saved the patient the discomfort of a sinus persisting for a year and a half.

Dr. Howard Lilienthal, discussing Dr. Tilton's suggestion that in some cases of perinephritic abscess an examination of the kidney itself might reveal its tuberculous character and lead to an immediate nephrectomy, said that in many instances where the abscess was large and the kidney in bad condition such a procedure would cause tremendous shock. On the other hand, by drainage and delay, we were apt to get troublesome adhesions, and to obviate these difficulties the speaker said that in a number of cases he had resorted to a nephrectomy in two stages. He first opened the abscess and drained the kidney, if necessary, and then, five or six days later, removed the kidney. By that time the size of the organ would have diminished, the abscess cavity would be largely obliterated, and the completion of the operation would be comparatively safe and easy.

APPENDICITIS: A SERIES OF 105 CONSECUTIVE OPERATIONS WITHOUT MORTALITY.

Dr. Charles N. Dowd read a paper on this subject, and showed a number of patients illustrating the same. (See page 762.)

Dr. Lilienthal said it was not often that we heard of 105 unselected consecutive cases of appendicitis without a death. Both Dr. Dowd and the patients were to be congratulated upon such an excellent showing. The speaker said he was heartily in favor of the method described by Dr. Dowd, and had practiced it himself. Its main feature was not to interfere any more with the peritoneum than was absolutely necessary, neglecting the presence of intraperitoneal fluid, even pus.

POPLITEAL ANEURISM: RECONSTRUCTIVE OPERATION.

Dr. John A. Hartwell presented a man, 42 years old, who was admitted to Bellevue Hospital on February 11, 1909. His family history was unimportant, and he gave an indefinite history of syphilis. His occupation, which was that of a machinist, entailed hard work, but there was no history of his ever having injured his knee.

About six months ago he noticed a small swelling in the left popliteal space, which had gradually increased in size. It was the seat of a constant dull, aching pain. At times he had noticed that his leg was of a bluish color, but there had been no symptoms referable to nerve pressure.

Physical examination in general was normal, and there were no positive evidences of syphilis. In the left popliteal space there was a typical aneurismal swelling the size of an orange, which gave all the classical signs of that condition. It was apparently of the sacculated type. Pulsation was absent in the dorsalis pedis and posttibial arteries.

Operation, February 19, 1909, under gas and ether anæsthesia. A Martin bandage was applied from the foot to the upper third of the thigh, completely emptying the sac. An 8-inch incision was then made over the tumor and carried downward through the tissue to a false aneurism sac, with the vein and artery lying on its external, posterior aspect. The sac was then opened, freed of blood clots, and was found to communicate with the arterial lumen by two openings lying on the anterior internal aspect of the artery. There were no blood clots in the inside of the artery, and the arterial wall, although somewhat dilated and thickened, seemed comparatively normal excepting at the sites of the rupture. The intima seemed normal. The two openings, one about an inch and a half, the other about half an inch in extent, were closed with fine silk, thoroughly vaselined, threaded on No. 16 needles. Two rows of sutures were applied in such a way as to closely approximate the intimas. The constricting bandage was then removed and the blood freely pulsated through the artery. It was then noted that the condition was a fusiform aneurism, and with the full force of the circulation the artery dilated in its centre to about one inch in diameter, the longitudinal extent of the dilatation gradually decreasing in either direction for about two inches. It was feared that a recurrence would take place if left in this way, so a further operation was undertaken. The artery was digitally compressed above the seat of the disease, the fusiform sac was split throughout its length, and a reconstructive operation was done, leaving a canal of normal size, the intimal surfaces being brought in contact by means of chromic gut sutures on a curved needle. The remainder of the sac was sutured down over this with chromic gut, three layers in all being used. On releasing the compression, blood circulated freely through the newly formed canal. The wound was sutured with a small drain in the false sac.

Circulation in the leg and foot was sufficiently good on the day following the operation, although no pulsation ever returned in the distal arteries. Four days after the operation there was evidence of a blood collection in the false sac, with a rise in temperature. The superficial wound was opened, and a collection of blood and serum evacuated which was just beginning to undergo suppuration. This was washed out and a drain inserted. An examination of the reconstructed artery showed pulsation as far down as the middle of the operative site; below this it was obstructed, with the evident formation of a clot. At the second dressing, two days later, this clot occluded the entire site of the arterial operation.

On March 20, the first time the patient was allowed out of bed, there was a sharp hemorrhage, which was controlled by a tourniquet, applied for half an hour, with subsequent firm pressure over the popliteal space. The source of the bleeding was not determined. The subsequent history of the case was uneventful. The wound in the false sac granulated, leaving a moderate amount of contraction at the knee joint, which was gradually growing less.

The case was shown because of the interest attached to the failure of the reconstruction of the artery, although the result, so far as the circulation in the leg was concerned, was entirely satisfactory. It was not believed that the infection within the false sac was in any way the cause of the failure, because the artery itself was not in contact with the infection, and that part of the operative field showed no evidence of suppuration at any time. If an infection in the arterial wall was present, it was not sufficiently marked to show gross signs. Had the necessity for reopening the wound not arisen, so that direct inspection of the artery was possible, the case would undoubtedly have been accepted as one of success of the reconstructive operation,—for the functional result was good, and any subsequent absence of pulsation in the popliteal artery would have been explained by the formation of cicatricial tissue over and around it.

SECONDARY GASTRO-ENTEROSTOMY.

Dr. Hartwell presented a man of 34 who was admitted to Bellevue Hospital on April 9, 1909. His family history was unimportant. He was operated on at Bellevue Hospital in 1903 by Dr. George Woolsey for an acute exacerbation of recurrent appendicitis, and the appendix was removed. His recovery from that operation was uneventful. He was readmitted to the hospital, in Dr. Woolsey's service, on January 14, 1908, and gave the following history: For the preceding eight or nine months he had suffered from symptoms pointing to gastric ulcer, and he had been treated in the City Hospital for that condition. His chief symptoms were gastric pain and the vomiting of blood. On January 11 he was seized with persistent vomiting, and there was more or less abdominal pain, which was most severe in the region of the epigastrium.

Examination on admission gave the findings of a subacute perforation of a gastric ulcer, for which an immediate operation was done by Dr. Woolsey. Examination of the stomach showed some adhesions about the posterior wall in the lesser sac, which was the apparent site of the ulceration. The pylorus was found to be patent, and the stomach was not materially dilated. No acute perforation was present, and, in the absence of pyloric stenosis, a gastro-enterostomy was deemed inadvisable. The adhesions on the posterior wall were not disturbed. The post-operative course was uneventful, and the patient was discharged on February 4, apparently in good health, and without gastric symptoms. He remained well until March, 1909, when there was a recurrence of the previous symptoms. For three weeks prior to his recent admission to Bellevue Hospital on April 9, he had been suffering almost continuously from colicky, cramp-like pains in the epigastrium, radiating under the costal margin to the right lumbar region, and occasionally to the left shoulder. He had vomited practically everything ingested during this time, but there had been no blood in the vomitus.

The patient had the facies of abdominal suffering and was moderately emaciated. Examination showed no abnormality excepting that due to the abdomen. Here, scars of the previous operation were seen, and palpation over the epigastric region, particularly just beneath the ensiform, caused marked pain. The stomach was apparently enlarged. No masses could be made out and there was an absence of abnormal rigidity.

Gastric analysis, one hour after a test meal, showed 250 c.c. of undigested food. Total acidity, 50 c.c.; free hydrochloric acid, 10 c.c.; loosely combined acid, 22 c.c. No lactic acid. During the week that he remained under observation in the ward he suffered constant pain, but on a very limited diet; there was no vomiting.

Operation: This showed the stomach to be dilated to at least twice its normal size, though the pylorus seemed to be patent. There was a marked absence of adhesions. On the anterior surface of the stomach, near the lesser curvature, and about an inch and a half from the pylorus, there was an indurated area, apparently the seat of an ulcer. On opening the lesser sac through the transverse mesocolon there was an absence of the adhesions described at the previous operation, and no evidence of ulceration existed. Posterior gastrojejunostomy was done by the no-loop method without reversal, sutures and clamps being used.

Since the operation, the patient has been entirely free from pain, and there has been no vomiting excepting on the second day, when he vomited a small quantity of powdered milk curd, the first food ingested.

PRIMARY TUBERCULOSIS OF THE BREAST.

Dr. Hartwell presented a woman, 21 years old, who was admitted to Bellevue Hospital on February 19, 1909. Her family history was good, as was also her past history. There were no evidences of tubercular or venereal infection. She had never been pregnant.

About nine weeks prior to her admission to the hospital, the patient, on stooping, struck the lower outer quadrant of her left breast rather sharply against the corner of a table. Four weeks later, the breast, at the site of the injury, began to swell and show evidence of an inflammatory reaction, with the subsequent development of an abscess. One week ago this was incised, a small quantity of pus was evacuated and the cavity was drained.

Physical examination at the time of admission showed the patient to be a well-nourished young woman, above the average height, and of rather slight build. Aside from the condition of the left breast, examination showed nothing abnormal excepting scars on the inner aspect of the left arm and low in the axilla, the result of an old burn. The left breast was the seat of an inflammatory lesion involving the lower outer quadrant. There was a swelling, irregular in outline, lobulated, giving somewhat the feel of an adherent mass of glands, the skin over which was reddened and ulcerated in the centre, with a discharging sinus. The general appearance of the skin and sinus, with the granulation tissue underlying it, was that of tuberculosis. The involved portion of the breast was firm to palpation, and gradually shaded off into the normal breast tissue surrounding it. The diseased portion was somewhat tender to manipulation, and the axillary lymph-nodes were distinctly enlarged and tender.

The patient's temperature, on admission, was normal; pulse, 70. The leucocyte count was 16,000 with 74 per cent. polymorphonuclears. An incision made in the centre of the lesion prior to the resection evacuated a considerable quantity of tuberculous-looking pus. A small section of the tissue about the sinus was removed and submitted to Dr. Charles Norris, who pronounced it a tuberculous inflammation. The Von Pirquette and Calmette reactions were both negative.

Operation, March 26, 1909: This included a complete resection of the breast and axillary contents, the pectoral fascia being removed because it seemed to be involved in the process, but the muscles themselves were not disturbed.

The wound healed throughout the greater part of its extent primarily, although a small sinus persisted near the centre, which healed by granulation. About three weeks later a small collection of pus again formed at this site, and here a sinus still persisted. Material taken from this sinus on May 10 by curettage showed microscopically granulation tissue, without giant cells, and without definite evidence of tuberculosis. A second Von Pirquette done on May 10 gave a negative result.

The complete pathological report on the specimen removed was as follows:

> The specimen consists of a breast and axillary contents. Just above the nipple is a circumscribed ulcer about 15 mm. in diameter, circular in outline, with sloughing base, which extends almost completely through the skin. Just to the outer side of the nipple is another ulcerated area about 15 mm. x 30 mm., of similar character, extending completely through the skin. On section of the breast tissue, there is a diffuse, pale, firm mass, invading the fat tissue, this lying immediately beneath the nipple and below it. Tissue of similar character is present immediately subjacent to the ulcers described. The lymph-nodes in the axilla are slightly enlarged and pale.
>
> MICROSCOPIC SECTIONS of the breast show slight hyperplasia of the glandular structure. The firm, white tissue described grossly is seen to consist of œdematous connective tissue between the fibrils, of which there is a considerable accumulation of lymphocytes in larger and smaller masses, and in places one sees definite circumscribed collections of epitheloid cells, the outer zone of which is bounded by lymphocytes; many of these contain large giant cells with their nuclei peripherally and radially situated. These tubercles are seen not only in the dense mass described, but in lymph spaces at some distance from the larger mass. Subjacent to the superficial ulcers are seen small clefts in the tissue lined by cells of similar character and distribution to those above just described.
>
> Diagnosis: Tuberculosis of mammary gland.
>
> The axillary lymph-nodes show evidence of chronic hyperplasia, without evidence of granuloma or tumor. No tubercle bacilli could be demonstrated in section of the breast stained for them. The spirochæta pallidum was also absent.

The case was presented because of the comparative rarity of tuberculosis of the breast as an apparent primary lesion. A most careful physical examination in this case fails to disclose any evidence of any other focus of the disease.

Dr. Alexander B. Johnson said he wished to put on record a case of primary tuberculosis of the breast which came under his observation some years ago. The patient was a middle-aged woman with a tumor of the left breast which she said had existed for several years, but which had recently begun to increase rapidly in size. The appearance of the growth was that of a large carcinoma, involving almost the entire breast. The skin overlying it was reddened, and it suggested an extremely rapid type of malignant disease. The glands in the axilla were moderately enlarged. Upon removing the breast, together with the muscles and the axillary contents, it was found that the tumor was an ordinary fibro-adenoma; but the entire gland, including the nipple, was the seat of an acute miliary tuberculosis. The enlargement of the axillary lymph-nodes was due to a simple inflammation. The woman made a perfectly good recovery.

OPERATIVE TREATMENT OF FRACTURE OF THE NECK OF THE FEMUR.

Dr. Royal Whitman presented six cases illustrating operative methods in the treatment of fracture of the neck of the femur for the purpose of restoring the function of the injured part. The first patient was a girl 16 years of age, who two and a half years ago was brought to the Hospital for Ruptured and Crippled for the treatment of what was supposed to be hip disease. A diagnosis of epiphyseal fracture of the neck of the femur was made and the joint was opened by the anterior incision, exposing the extremity of the neck which, as in all cases of this type, was displaced upward and forward, lying in front of the head of the femur. A thin section was removed sufficient to permit the insertion of a chisel between it and its head, and by prying and rotation of the limb the displaced parts were brought into perfect apposition. The patient, who at the time of the operation was completely disabled, is now presented as a perfect functional cure.

The second patient shown was a girl 15 years of age who had been admitted to the hospital in December, 1907, for hip disease. The limb was flexed, rotated outward, and there was pain and muscular spasm on attempted motion. There was no history of injury. The joint was opened and the displacement was identical with that of the last case, as was the treatment. The result also was perfect functional recovery.

The third patient was a young man 19 years of age, who fourteen months before he had come under observation had fallen on the ice, the injury causing apparently an incomplete epiphyseal separation. He continued to limp about for a year or more when another fall completed the fracture and caused practical disability. The same operation was performed as in the other cases, but the replacement of the fragments was somewhat more difficult owing to the delay. The result is very satisfactory. There is but slight limp, a fair and increasing range of motion. The patient suffers no discomfort and is at work as the driver of a truck.

The fourth patient, a boy 16 years of age, differed from the others in that he was of the large, fat, overgrown type in which there was evident predisposition to deformity. The fracture had been induced by a slight injury. The operation was performed about six months after the injury; the method and the result differed in no essential from those of the preceding case.

The fifth patient, an amateur acrobat 18 years of age, about two years ago had fallen a distance of thirty feet. He was taken to a hospital where he received the accepted treatment for an impacted fracture of the neck of the femur. Two months later he was discharged with the advice that the limb be used; but as there had been no improvement he came to the Hospital for Ruptured and Crippled, where he was admitted for the treatment of ununited fracture of the neck of the femur. Upon opening the joint it was found that the neck of the femur had been in great part absorbed by the friction induced by motion and pressure. Its extremity was freshened, brought into apposition with the head and fixed by a drill passed through the trochanter. Firm union resulted. There is now free and painless motion but slight limp, and function is steadily improving.

This case illustrates the fact that inefficient treatment, even in a most favorable case, may be followed by the same unfavorable result as when applied to the adult type of injury.

The last patient was a boy 12 years of age, who two years ago fell from a car, fracturing the neck of the femur. He received no treatment and union followed with deformity of the coxa vara type. He was admitted to the hospital last year because of limp, pain and distortion of the limb—symptoms directly dependent upon the depression of the femoral neck. The indication was therefore to restore the normal angle, and this was accomplished by the removal of a wedge of bone from the base of the trochanter, sufficient to permit full abduction of the thigh. The result is perfect functional recovery.

ENDOTHELIOMA OF THE CAROTID BODY.

Dr. Howard Lilienthal presented a woman, 56 years old, who gave a history of having had a small lump on the left side of the neck for the past thirty years. For the past five years this had become considerably larger, especially during the past year, when she became alarmed and wished to have it removed. The diagnosis of tumor of the carotid body was made before the operation, which was done about a month ago.

Upon exposing the growth, it was found that it involved the vessels to such a degree that it became necessary, as a preliminary step, to ligate and sever the internal jugular and common carotid quite close to the clavicle. The incision extended from below the ear, forward to the midsternal region, and then backward along the clavicle. The dissection was an extremely difficult one, lasting over an hour. The left pneumogastric nerve rested on the posterior surface of the tumor and was peeled off, as the speaker said he did not want to run the risk of causing the sudden death of the patient by resecting it.

On the day after the operation the patient was completely aphasic and had a well-marked hemiplegia. The left eyeball was soft, with contraction of the pupil. The aphasia and the paralysis of the hand due to the cerebral anæmia rapidly disappeared, but the pupil of the left eye was still smaller than that of the right. The ocular symptoms were due to injury of the superior cervical sympathetic ganglion.

In discussing the prognosis of this case, Dr. Lilienthal said he had not the slightest doubt that there would be a local relapse. He recalled a similar case which was inoperable, where the patient finally became cachectic and died of general weakness, but without metastases.

Dr. John F. Erdmann said that about ten years ago he operated on a case in which he excised about half an inch of the left pneumogastric nerve without any resulting bad effect.

VOLKMANN'S ISCHÆMIC PARALYSIS.

DR. HOWARD LILIENTHAL presented a boy of 12 years who in September, 1908, fell while walking in the street, breaking both bones of the right forearm. The double fracture was treated by an anterior and posterior splint. Subsequently, he developed a marked case of Volkmann's ischæmic paralysis, for which he was operated on by Dr. Lilienthal on January 18, 1909, four months after the accident.

An incision was made over the radius and ulna, removing about an inch of bone from each, and then introducing intramedullary aluminum splints, as devised by Dr. Charles A. Elsberg, and the hand was put up in the position of extreme extension. Primary union with good position of the hand followed the operation, but gradually the arm again became somewhat contractured. The elbow was now perfectly straight, and the boy had good use of the hand, thanks to the untiring efforts of the patient's mother who practised daily massage and passive motion.

DR. WHITMAN said he would advise in all cases of this character, before resorting to resection of the bone, the gradual correction of the deformity by splints, after the method of Jones. It was a treatment, however, that required a persistent attention for many months, without which it would always fail.

DR. ALFRED S. TAYLOR said that a little over a year ago he presented a case in which he had done the same operation as that described by Dr. Lilienthal, and, as in this case, there was a recurrence of the deformity. That recurrence took place in spite of vigorous and faithful massage by a professional masseur. The trouble in his case, Dr. Taylor thought, was due to the fact that the muscles were cicatrized, and the bones, after having been resected, continued to grow. He saw no good reason for shortening the bones nor lengthening the tendons, because both of these steps were unnecessary if there was sufficient muscle tissue. According to the literature, the method advocated by Jones had given many good results. There was another method which he had resorted to in cases of strong contracture of the muscles, and in one instance where there was marked posterior deformity of the wrist. Within four months, by the method described by a French writer named Martin, the hand could be brought into a position of extreme flexion. The method consisted, essentially, of building a steel framework over the forearm, and applying elastic traction to the contractured muscles. This method was much more effective than any plan of rigid extension, such as was advocated by Jones.

Another important factor in the treatment of Volkmann's ischæmic paralysis, Dr. Taylor said, was to pay particular attention to the condition of the nerves. They should be released at the earliest possible moment from cicatricial pressure, so as to hasten regeneration.

Dr. Lilienthal, in closing, said that while in certain cases he might be induced to try massage and passive extension without operation, he was convinced that any apparatus that was put on an arm of this kind had to be watched with the greatest care,—otherwise, ulceration was apt to result, as in these patients there seemed to be an inherent tendency to traumatism of the soft parts. As to the danger of non-union after resection of the bones, that possibility could be avoided by the use of the intramedullary splints.

MULTIPLE LIVER ABSCESSES.

Dr. Lilienthal presented a man, 43 years old, who was admitted to the hospital on March 23, 1909, with the history of having had three attacks of gall-stone colic, the last one being accompanied by slight jaundice and fever.

Examination showed marked tenderness and rigidity in the right hypochondrium. The blood count showed 15,200 white cells, with 95 per cent. polymorphonuclears. On March 26 the abdomen was opened through the right rectus muscle, exposing the gall-bladder. The entire surface of the liver, particularly the left lobe, was studded with small abscesses, and by palpation one could make out crater-like depressions in various parts of the liver. A number of these abscesses were incised, evacuating considerable pus. The gall-bladder was then opened and drained, after removing a number of calculi. The patient made an uneventful recovery, with the exception of a gall-bladder sinus which still persisted. A culture from one of the abscesses showed a bacillus coli infection.

This case was shown, Dr. Lilienthal said, on account of the extreme rarity of this condition. It was the second case he knew of where recovery took place after multiple miliary abscesses of the liver had been actually demonstrated at operation.

INTESTINAL RESECTION FOR STRANGULATED HERNIA.

Dr. Lilienthal presented a man of 30, who on March 28, 1909, developed acute intra-abdominal symptoms which his physician recognized as being due to a strangulated left inguinal hernia, and advised him to go to the hospital at once. The man refused to go until the next day, and when Dr. Lilienthal saw him that morning the patient was in a condition of extreme shock as the result of a very aggravated form of strangulation, with œdema and ecchymosis involving the abdomen, scrotum and penis.

An immediate operation was done, disclosing a mass of blackened intestine which had entirely lost its lustre, and which involved at least four feet of what was apparently the ileum. The mesentery was thrombosed, with an entire absence of pulsation. It was incised in several places without resulting blood flow. A rapid resection of the gut was made by the method which Dr. Lilienthal had described at a meeting of the society several months ago. The segment that was to be resected was first tied off, then cut, the cut ends carbolized, and a side-to-side anastomosis made. The patient made an excellent recovery. The ends of the sutures used in tying off the gut were left hanging out of the wound, and came away on the fourteenth day. There was never any leakage of intestinal contents. By actual measurement, four feet of gangrenous intestine was resected.

Dr. Lilienthal said he showed this case with the object of again emphasizing the ease and rapidity with which this method of intestinal resection could be completed. In this case the patient's condition was such that any prolonged method would probably have proven fatal. In reply to a question, the speaker said he regarded the side-to-side anastomosis much quicker than the end-to-end, and in cases demanding great haste it was infinitely safer.

INJURIES OF THE KIDNEY.

Dr. Alexander B. Johnson read a paper with the above title, for which see page 715.

Dr. Lilienthal said that one thing that struck him in listening to Dr. Johnson's paper was the enormous disparity between the number of cases of injury to the kidney in the male as compared to the female, and this difference was hardly explained satisfactorily by the reason given by the reader of the paper. It was perhaps due to the fact that cases of movable kidney were much more frequently met with in the female than in the male, in children as well as in adults, and a freely movable organ was much more likely to escape injury than one that was firmly fixed.

Dr. Ellsworth Eliot, Jr., briefly reported a case of posterior shot wound where the bullet, after perforating the gall-bladder, grazed the hepatic flexure of the colon and then passed through the right kidney and a part of the pedicle. The injury produced an extensive extravasation of blood. The gall-bladder and the injured kidney were removed, and the subsequent convalescence of the patient was interrupted by a perinephritic suppuration which was relieved by a counter-opening through the loin.

Dr. Benjamin T. Tilton reported a case of kidney injury, giving rise to symptoms similar to those of an acute peritonitis. The patient was a boy of 10 years who was run over. He was severely shocked, and about the seventh day showed signs of peritonitis, viz., abdominal rigidity and tenderness, a high temperature, and vomiting. A median incision was made, which disclosed some free serous exudate in the peritoneal cavity. A second incision was then made over the kidney, opening a urinary abscess originating from a ruptured kidney. The abscess was drained, the peritoneal symptoms subsided, and the boy made a good recovery.

CORRESPONDENCE

"TOTAL EXCISION OF THE SCAPULA FOR SARCOMA."

EDITOR ANNALS OF SURGERY:

In the ANNALS OF SURGERY for July, 1909, Dr. de Nancrède publishes an exceedingly interesting article giving the end results after total excision of the scapula for sarcoma. He has succeeded in collecting 65 cases in which the scapula alone was excised, and 9 in which more than the scapula was removed, 25 of these cases being tabulated by him for the first time.

Dr. de Nancrède's conclusions are certainly very pessimistic, but no more so than the statistics would seem to warrant, while between the lines one can probably read a doubt as to the correctness of the diagnosis in the few cases in which death did not ultimately follow from recurrence. It is probable that quite a number of other cases could be reported, but it is hardly likely that any of the successful ones have failed to be recorded.

While it is doubtless true that the prognosis in these cases is almost absolutely hopeless as to end results, nevertheless the operation itself presents no technical difficulties. Its immediate mortality should be almost *nil*, and the patient will have at least a few months of comfort and of hope, while there is always a bare possibility of even a permanent cure.

The two cases which I report only strengthen the contention of Dr. de Nancrède.

CASE I.—Mr. F. K., aged 56; farmer; Grove City, O. November 26, 1901. Physician, Dr. William Hoover. First noticed pain and stiffness in right shoulder about a year before. This had at first been regarded as rheumatic, but a growth manifested itself in three or four months. Had lost 15 pounds in weight. Pain quite severe. On personal examination the tumour was found to be nearly the size of the fist, and to have involved in its growth the joint and probably the upper end of the humerus. The axillary glands were also involved.

At the operation the entire clavicle and scapula were removed, together with the arm, and thorough cleaning out of the axilla. The growth was pronounced an osteosarcoma. Patient went through the operation nicely, and went home in fine shape. There was no recurrence at the point of operation, but the right lung became involved, and he died March 23, 1902.

Case II.—Mrs. J. M. K., aged 39; West Leipsic, O. Physician, Dr. C. E. Beardsley, Ottawa, O. September 8, 1904. The patient was mother of four children. Eighteen months before had fallen in such a way as to strike the point of the right shoulder. No bruise was noticed at the time, but some soreness had persisted and had been attributed to rheumatism. A lump had been noticed two weeks before. Pain was of a dull character. Motion of the arm somewhat limited. Patient was an exceedingly well-nourished woman, the picture of health. The tumor involved the right scapula, was smooth in outline, and somewhat elastic. Did not extend above the spine. Skin not involved. The tumor seemed to be about two inches thick. (A brother of the patient had died of osteosarcoma.)

At the operation the entire scapula was removed, the operation being attended with no special difficulties. The disease seemed to be limited to the body of the bone, though both anterior and posterior surfaces were involved. The spine and other bony processes seemed to be free from disease. No involvement whatever of the clavicle, humerus, or the joint.

Patient made a rapid convalescence and returned home in fine condition and with very satisfactory use of the arm. She remained free from any evidence of return until the following February; then there was a gradual development of a general sarcomatosis, and she died October 5, 1905.

The extent of the tissue involved in the first case led necessarily to a very unfavorable prognosis, and the recurrence was so prompt as to render it perhaps questionable as to whether anything was gained by the operation. At the time of the operation, however, every motion of the arm was attended with great distress, and this was entirely relieved by the surgical intervention. In the second case there was a clear gain of several months of good health, and I think life was unquestionably prolonged by the operation.

James F. Baldwin, M.D.

Columbus, Ohio.

ANNALS OF SURGERY

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ORIGINAL MEMOIRS.

A STUDY OF BURNS INVOLVING THE PERIOSTEUM OF THE VAULT OF THE SKULL.

BY J. M. MASON, M.D.,

AND

B. S. LESTER, M.D.,

OF BIRMINGHAM, ALABAMA.

WE have recently had the opportunity of treating, at the same time, two cases of extensive burns of the vault of the skull, destroying the periosteum over large areas of the parietal, occipital and frontal bones.

Both cases were treated on the expectant plan; that is to say, the burns were treated antiseptically and we waited for the denuded bone plates to be cast off.

In one case this occurred without accident or complication, and final healing resulted. In the other, the patient progressed satisfactorily for a month, when he suddenly developed hemiplegia, aphasia, and coma, and died from a large brain abscess.

A consideration of these cases, with autopsy notes on the fatal case, and examination of the exfoliated occipital and frontal bones from the other case, teaches us the pathological process which will result from destruction of the periosteal covering of the cranium.

CASE I.—T. R., black male, aged about 25, was admitted to

St. Vincent's Hospital August 22, 1907, suffering from electric burns of right hand and forearm, requiring amputation, several slighter burns about the face and body and a burn over the left parietal bone extending down to the periosteum.

After amputation of the forearm, the burns were dressed antiseptically. In a few days the burn on the skull had cleaned off, leaving the parietal bone exposed over an area of about three inches, the centre of which was near the parietal eminence.

While his other wounds were in process of healing, the patient had a little fever, after which his temperature remained under 99, and his general condition was good, until September 19, when he had a sudden rise of temperature accompanied by hemiplegia, and quickly followed by stupor and death on September 23, 1907.

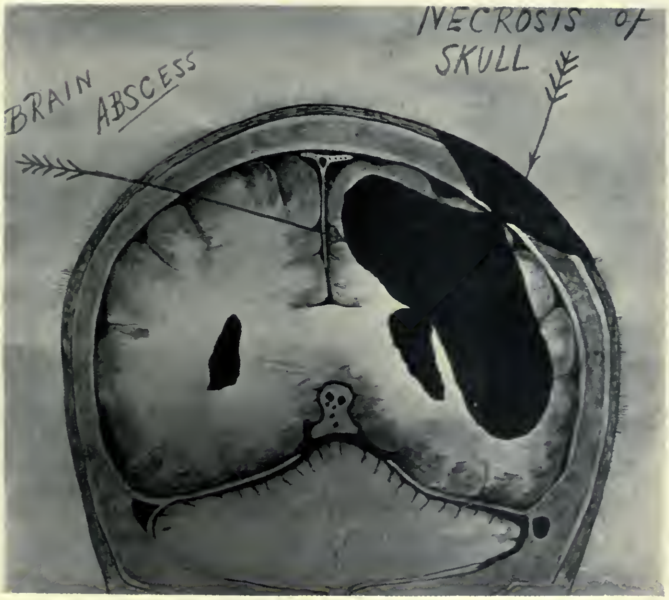
An autopsy was secured, with the following findings: The outer table of the parietal bone was necrosed over the area of the original burn, but was not detached from the surrounding bone. The inner table under the centre of the burn of the outer table showed a circular area of osteitis concentric with the outer table but less than half the diameter of the outer dead layer. This had not separated from the healthy bone around it.

Opposite the centre of this circle, where it was in contact with the dura, there appeared upon the dura a circular suppurating spot about the size of a five-cent piece. On the under surface of the dura opposite the centre of this spot was a very much smaller suppurating focus, and where this came in contact with the brain was a minute point showing where the infection reached the surface of the brain. Immediately beneath this, in the tissues of the brain, was located an enormous abscess, destroying a large part of the left hemisphere (Fig. 1).

The necrosis and infection had traveled downward and inward toward a point corresponding to the centre of the original circular burn of the parietal bone, each layer of tissue showing an area of infection and necrosis smaller than the one above it, until, at the point of contact with the brain, only a minute spot of infection was apparent. As soon, however, as the brain tissue was invaded, the infection traveled with great rapidity, quickly destroying nearly half the cerebrum.

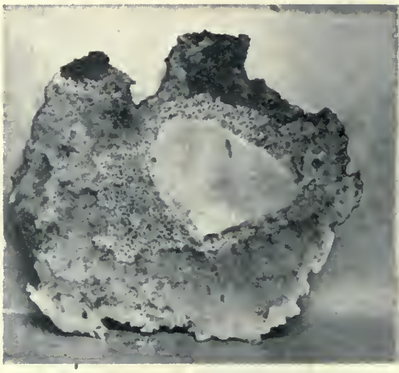
Case II.—T. S., colored male, aged about 25, was admitted to St. Vincent's Hospital, September 8, 1907, suffering from an electric burn three inches in diameter over the middle of the frontal bone, and another several inches long extending from the

FIG. I.



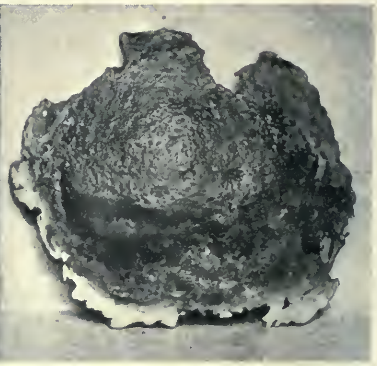
CASE I.—Cross section of head (diagrammatic), showing mode of infection of brain from necrosis of skull.

FIG. 2.



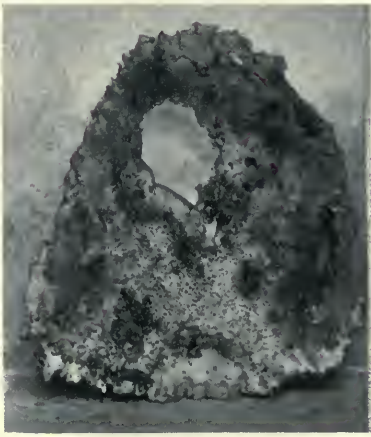
CASE II.—Occipital sequestrum. Inner surface.

FIG. 3.



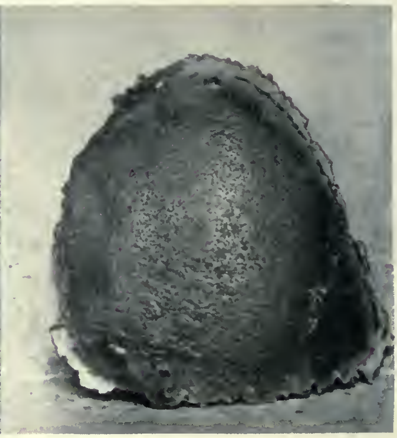
Outer surface.

FIG. 4.



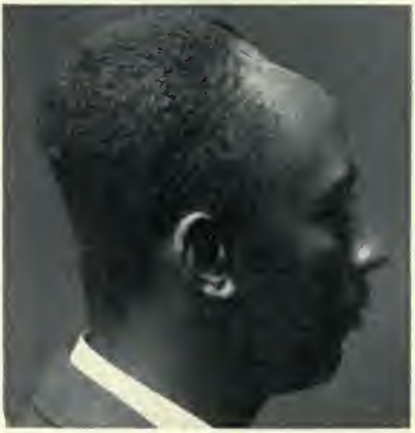
CASE II.—Frontal sequestrum. Inner surface.

FIG. 5.



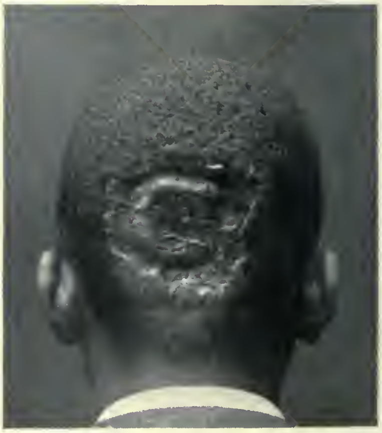
Outer surface.

FIG. 6.



CASE II.—Frontal cicatrix.

FIG. 7.



CASE II.—Occipital cicatrix.

upper part of the occipital bone well down on the neck. Both these burns charred the tissues down to the bones of the skull. There was also a third degree burn, several inches in diameter, over the left side of the chest.

The injuries were dressed antiseptically, and in a few days the burns on the head had cleaned off to the skull. The other burns were treated antiseptically until they had granulated sufficiently, when they were successfully grafted by Dr. Lester. We decided to pursue a waiting policy in dealing with the burns of the periosteum. While awaiting for separation of the sequestra, the rims of scalp around the borders of the burns were successfully grafted.

There was no tenderness under the area of exposed bone, and the patient ran a normal temperature. He remained in the hospital until October 31, and came back for dressings twice a week until December 20. We then lost sight of him until January 7, 1908, when we found the exposed bones loosened sufficiently to be lifted off (Figs. 2, 3, 4 and 5).

Near the centre of each exfoliated plate, the sequestration extended down through the internal table, and on removing the bone, the dura under these places was left bare.

The inner table was intact except for these central exfoliations.

These wounds were now dressed until the granulations were clean, and were then successfully grafted on January 22, 1908.

The head now presents a large cicatrix over the frontal bone and a similar one over the occipital bone. The brain is protected by the dura and by the inner table of the skull except near the centre of each cicatrix, where there is no bony layer. These layers are not much larger than half an inch in diameter, however, and are of no more seriousness than the opening left by a trephine of this size (Figs. 6 and 7).

The flat bones which form the vault of the skull are richly supplied with arterial blood through vessels which enter the outer table through the periosteum, and which enter the inner table through the endosteal layer of the dura. Larger nutrient arteries also enter the bones at different points.

The diploë lies between the outer and inner tables, and the interspaces are filled with channels for venous blood which finally leave the skull through various foramina at the base.

Anatomists differ concerning the presence of lymphatics in the dura or in the brain, so it is uncertain whether infection travels from bone to brain by this route.

If the inner table were as well supplied with blood as is the outer table, it is probable that, with destruction of periosteum, there would only be a loss of the corresponding outer table of the bone, the nutrition from the under surface keeping the inner table intact.

This, however, is not the case, for in each of our specimens we find the outer table entirely destroyed, most of the inner table present, but presenting an irregularly circular necrosed area, corresponding to the centre of the destroyed outer table.

This indicates that the circulation is entirely unable to preserve the outer table, and we may expect it, in any case of extensive burn, to be cast off. The circulation in the inner table is sufficient to preserve the life of a large part of this table, but the central portion gives way, the entire thickness of bone being cast off and leaving the dura exposed.

Blood reaches the venous channels of the diploë directly through the bone overlying and underlying a given part, and the circulation must be free in a lateral direction from a given point. Hence, if the periosteum is destroyed over a given area, the direct blood supply from this area is cut off, and the blood supplied the underlying area must reach it from the dura below the inner table, and laterally from the zone of healthy bone around the margin.

Under the centre of the denuded area lies the part furthest removed from the healthy margins, and here the venous thrombosis and superadded infection are greatest, and the inner as well as the outer table are destroyed and cast off.

In most cases of this sort, no doubt the exfoliation of the exposed skull will continue in a favorable manner and without infection of the dura and the brain, but the course of the first of my cases shows that such will not always be the case.

When the periosteum over these large areas is destroyed, we may be sure that necrosis will follow, and I have endeavored to find out what could be done to prevent such a disastrous termination as followed the waiting plan in Case I.

It occurred to us that one might chisel off the outer table over the entire denuded area, and graft the surface of bone as soon as it showed satisfactory granulations. However, upon examining a parietal, an occipital or a frontal bone, one at once sees that there are very thin areas, of considerable extent all about these bones, where the internal table is not distinctly separated from the external table, and where one could not remove the outer without the inner table. Indeed, on several fresh cadavers we were unable to make any satisfactory removals after this plan.

In the first case, which died thirty-one days after receipt of the injury, we found that the necrosed bone had not begun to separate at the end of four weeks, and in the case that finally recovered, we found that it was at least three and one-half months before separation was complete. From this we know that a period approximating three or four months is required for separation and removal of sequestra.

We noted in the burns of all the bones of the vault of the skull, that the outer table was cast off over the entire area which is bared of periosteum but that the inner table is only destroyed over a small area corresponding to the centre of the necrosed outer table, and that the brain infection is received by contact with this inner area of inflamed bone.

If drainage is established at this central point, infection should not travel through the dura, and proper dressings ought to protect the brain until such a time as the rest of the necrosed bone is thrown off and the whole area covered with grafts.

Our suggestion for treatment is, therefore, that every such case be treated antiseptically until the sloughs of the soft parts have been cast off or cut away and the bone left bare and clean. This will only take a few days. After this, a trephine opening about half an inch in diameter should be made over the centre of the denuded bone, and the button removed down to the dura.

The wound should now be dressed antiseptically until such a time as the denuded bone is cast off, the drainage provided for at the centre being relied upon to take care of any infection which reaches the dura, after which the whole area should be grafted, as was done in our second case.

THE OPERATIVE TREATMENT OF CANCER OF THE LARYNX.*

BY GEORGE EMERSON BREWER, M.D.,

OF NEW YORK,

Surgeon to the Roosevelt Hospital.

CANCER of the larynx, whether considered from the point of view of the laryngologist or the general surgeon, presents one and the same problem. Can the victim of this dread disease be subjected to any form of treatment which will offer a probability or possibility of cure, or, if not, can anything be done to mitigate his sufferings?

From the earliest period at which the disease was recognized, not one authentic case of carcinoma of the larynx was ever cured except by early surgical removal of the disease.

As the death rate, therefore, in this condition treated by non-surgical methods has been, and is, 100 per cent., no time need be wasted in the consideration of non-operative treatment.

Four methods of radical surgical treatment have been proposed. First, intralaryngeal removal; secondly, thyrotomy, allowing exposure of the diseased area and removal of the lesion with subsequent closure of the laryngeal cavity; thirdly, partial laryngectomy; and fourthly, total laryngectomy.

While authentic examples of the successful removal of a malignant growth from the larynx by intralaryngeal methods have been recorded by Franckel and others, and while in a few rare instances freedom from recurrence has been observed for a sufficient length of time to justify the belief that a radical cure has been obtained, the gross uncertainties of such a procedure, and the almost uniformly disastrous results which have followed the method, have led to its general condemnation and abandonment.

Thyrotomy or laryngotomy, although first performed by

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* Read before the Section in Laryngology, New York Academy of Medicine, May 21, 1909.

Brauers in 1833, was slow in acquiring surgical popularity, largely from the fact that in the beginning only advanced cases were operated upon and the results were correspondingly disappointing. Von Bruns, forty-five years later, in 1878, succeeded in collecting only 19 cases in which the operation was attempted for undoubted malignant growth. Of these, two died from the effects of the operation. Of the 17 who survived the operation not one was known to live more than a few months, the longest being the case of Sands, in which death occurred without local recurrence 22 months after the operation, but in which autopsy revealed metastasis in the kidney and suprarenal gland.

The publication of this report served for a time to discourage further employment of this method, until 1889, when Butlin again advocated the operation, and demonstrated that in early cases of intrinsic cancer, while the growth was limited to the vocal band or adjacent soft parts, thorough removal gave a fair chance for radical cure. In 1900 this author reported to the International Congress at Berlin, 27 cases of thyrotomy for malignant disease, with 3 deaths, and 3 cures of three years duration. Last year (1908) Mr. Butlin reported to the International Congress of Surgery at Brussels, 21 personal cases operated upon since 1890 with one death, and 12 patients alive and well three years after operation. At the same meeting Gluck reported nine personal cases of carcinoma treated by this method without mortality, 7 remaining well without recurrence,—period of time not stated; one submitting to a total laryngectomy six months after operation for recurrence, and one dying 2½ years after with visceral metastasis.

Semon, who with Butlin was one of the pioneers in the modern plan of treating all early intrinsic cases by this method, reports 19 personal cases with one death, 76 per cent. of cures lasting one year (he never having observed a recurrence after the first year). Since Semon's masterly presentation of the subject in America in 1904, the operation has steadily grown in favor, and is to-day the operation of choice in early cases of intrinsic cancer. I can not do better in this connection, than to quote Semon's advice regarding indications. "All intrinsic cases of cancer, not too extensive, not too near the posterior wall and not infiltrating the cartilages ought to be treated by thyrotomy."

Partial or hemilaryngectomy, first practiced by Foulis in 1878, is indicated in cases of unilateral intrinsic disease in which the lesion extends too far backward to promise a favorable result by simple thyrotomy, or when there is reason to believe that the perichondrium or cartilage is involved. As early as 1884 Hahn showed that the mortality was far below that of total laryngectomy. In 1897 Sendzick published 110 cases with a death rate of 26.3 per cent. Chiari reported 32 cases with 8 deaths, or 25 per cent. In 1902 Hartley reported 4 personal cases without mortality, and last year Gluck reported his own series of 43 cases, also without mortality.

Regarding the permanent results following this operation, Powers and White in 1895 recorded 101 cases, with 8 alive and well three years from the date of operation. Butlin in 1900 reported a series of 23 cases, of which 4 were free from recurrence at the end of three years.

Of Gluck's 43 cases, 5 of carcinoma and 2 of sarcoma were alive at the end of three years, while 13 had recurrence and later submitted to total laryngectomy.

Although the indications for this operation are not as frequently encountered as for thyrotomy or total laryngectomy, it has the great advantage that it preserves the normal oral or nasal respiration, and not infrequently allows the patient to retain a speaking voice of fair quality.

While there is a widespread impression that at present the mortality of this operation is higher than that of total laryngectomy, due to the fact that there is more difficulty in completely protecting the air passages from the secretions of the wound and pharynx, the statistics of Hartley and Gluck show that with careful technic the death rate is as favorable as in any of the other major operations in this region.

Total laryngectomy was first performed by Watson of Edinburgh in 1866. He was followed by Billroth, Heine, Maas, Czerny, and others. The first successful laryngectomy for malignant disease was that of Bottini, whose patient lived six years.

During the earlier period of this pioneer work, the results were so unfortunate, both as regards immediate mortality, and permanent cures as to render the procedure almost prohibitive.

Hartley, in a careful statistical review of the operation published in 1902, showed that prior to 1889 the death rate from operation was between 40 and 50 per cent., and the permanent cures only 7 per cent.

The cause of the immediate mortality of this operation was recognized by all careful observers to be, first the occurrence of inhalation pneumonia, and second the extension of infection from the wound downward along the cellular planes of the neck to the mediastinum.

The first notable advance in technic was that proposed by Gluck in 1881, who suggested and practiced prophylatic resection of the trachea and implantation of the distal extremity through a buttonhole cutaneous wound just above the suprasternal notch, thus cutting off all connection of the air tube with the wound and preventing thereby the entrance of pharyngeal mucous and wound secretions. He also advised complete closure of the pharyngeal wound and generous packing with iodoform gauze. The employment of the Trendelenberg posture successfully prevented the entrance of blood into the trachea during the operation, which still further reduced the immediate risk.

Since this period the reported results show a steady improvement. Terebinski, in 1904, collected 188 cases with a mortality of 27.7 per cent. Schmiegelow collected 54 operations between 1890 and 1897 which showed a death rate from operation of 22 per cent. Moline, 81 cases with 15 per cent. mortality. Jackson 9 personal cases with one death, or 11 per cent. In Gluck's latest report, made to the International Surgical Congress at Brussels last September, he gives a total of 128 personal cases, and states that he has had no operative death for the past four years in uncomplicated cases of total laryngectomy.

Regarding the end results of total laryngectomy for malignant disease, von Bruns from statistics collected in 1890 gives 10 per cent. of cures three years from the date of operation. Powers and White in 1895 collected a series of 208 cases, of which 15 were known to be living at the expiration of three years. If we deduct 73 who died as a result of these operations from the total number, it gives a percentage of 3 year-cures of 11. Hartley in 1902 estimated the permanent cures as 15 per cent. In 1908 Gluck reports, of 128 operations 20 patients were alive and free from recurrence at the end of three years, or a trifle over 15 per cent.

Two operations have been suggested to diminish the suffering in advanced and inoperable cases, tracheotomy and the starvation treatment recommended by Dawbarn. We are all aware of the relief which tracheotomy gives to the patient whose cancer has advanced to the stage of laryngeal stenosis, and who is hourly dreading asphyxiation. The discomfort and annoyance of the tracheal cannula are gladly accepted by these unfortunate patients in place of the painful spasm, distressing cough, and increasing difficulty in obtaining oxygen.

Regarding the starvation method or cutting off the chief arterial blood supply to inoperable malignant growths in and about the larynx, it may be said that it is deserving of a trial particularly in cancerous growths situated at the superior aperture of the larynx with marked dysphagia and constant cough. It must be borne in mind, however, that the typical Dawbarn procedure, that of complete extirpation of both external carotids was intended for growths of the face, lips, tongue, mouth, and upper pharynx. As the larynx is supplied chiefly by the superior and inferior thyroids, ligation of three of these trunks will accomplish all and more in these cases, than the typical carotid extirpation.

The writer's experience is limited to a single patient, but the relief in this instance was so striking that a brief history of the case will be given.

A middle-aged man, a butler by occupation, was admitted to the Roosevelt Hospital in the spring of 1901 suffering from hoarseness, a severe spasmodic cough, difficult and painful deglutition. He had suffered from these symptoms for three or four months, and had lost 10 or 15 pounds in weight, chiefly from loss of sleep and an inability to swallow food in sufficient quantities to maintain his strength.

On examination, a large indurated ulcer was seen involving the intra-arytenoid fold, somewhat more to the right than the left of the median line. There was moderate involvement of the adjacent lymphatics. He refused radical removal on account of the dangers and uncertainties of result, but gladly consented to the palliative operation.

Under chloroform anæsthesia, the right superior and inferior thyroid arteries were exposed and ligated, and also the left superior vessel. Within 48 hours he experienced a marked change in all of the painful symptoms. He slept without coughing, and was able to swallow with progressively increasing comfort. The wounds healed kindly, he left the hospital, and returned to his work. An examination made by several members of this society three weeks after the operation, showed that the ulcer had been reduced in size, and the surrounding tissues had lost their œdema and acute hyperæmia. He continued in this comfortable condition for several months, but later submitted to a tracheotomy for stenosis. The man expressed the greatest gratitude for the relief he obtained, and his life was undoubtedly prolonged by the treatment.

As the writer has had no personal experience in intralaryngeal removal of cancerous growths, or in hemilaryngectomy, he will report briefly his experience with thyrotomy and laryngectomy.

Thyrotomy I have performed 16 times with one death. Of these 16 cases only 7 were for undoubted carcinoma.

CASE I was that of a colored woman 41 years of age, with a recurrent epithelioma of the vocal cord. She recovered from the operation. Four months later she showed signs of a rapid recurrence, and total laryngectomy was performed (see Case I, under laryngectomy).

Case II was that of a middle-aged woman who had had symptoms of papilloma for two or more years. As the growth began to infiltrate the cord, she was referred to the writer by her physician, Dr. Charles H. Knight of this city. Under chloroform anæsthesia a median incision was made in the thyroid cartilage, the interior of the larynx widely exposed, the growth removed from the vocal cord and submitted to immediate microscopic examination by frozen section. As the diagnosis was epithelioma, the surrounding soft parts were thoroughly removed to the cartilage, the larynx packed, and the tracheal cannula left in place. She recovered nicely from the effects of the anæsthetic, slept quietly for nearly an hour, then suddenly awoke with a violent paroxysm of coughing in which the tube was expelled, and she died before it could be replaced.

Case III.—A man, 50 years of age, from Nanuet, N. Y., was admitted to the Roosevelt Hospital in July, 1904, suffering from a small intrinsic epithelioma of the left vocal cord. This was removed by thyrotomy, and the microscopic examination confirmed the diagnosis. He made a satisfactory convalescence, and remained well for two years and eight months, when he died of lobar pneumonia without any symptoms of a return of his laryngeal trouble.

Case IV.—Man, 49 years of age. Symptoms of laryngeal growth on left vocal cord for about one year. As the growth began to infiltrate the tissues of the cord, he was referred by Dr. H. Holbrook Curtis to the writer for radical removal.

On October 6, 1903, thyrotomy was performed, and the left cord and surrounding soft parts to the cartilage removed. He made a satisfactory recovery. Microscopic examination of the specimen showed it to be epithelioma. Two months later he returned, suffering from an apparent recurrence. A second thyrotomy was performed and a granulation removed together with a small area of the adjacent cartilage. His recovery from the second operation was uneventful. Examination of the specimen showed only granulation tissue. Two weeks ago I examined this patient and found no trace of his former disease, five years and eight months from the date of his first operation.

Case V.—A man, aged 60, was admitted to the Roosevelt Hospital, in July, 1906, suffering from a small nodule on the left vocal cord. Exposed by thyrotomy the growth was removed together with the adjacent soft parts to the cartilage. Microscopic examination of the specimen proved it to be epithelioma. He made a smooth recovery, but two months later returned with a slight recurrence. A second thyrotomy was performed and the growth removed together with a portion of the adjacent cartilage. He recovered from the second thyrotomy, only to return six months later for a terminal tracheotomy.

Case VI.—A man, 54 years of age, was admitted to the hospital in August, 1905, with carcinoma of one vocal cord. The diagnosis was confirmed by microscopic examination of the specimen removed by Dr. Jonathan Wright. Thyrotomy, with complete removal of diseased area. Smooth convalescence, patient left the hospital on the twenty-second day. Nine months later the patient was re-admitted with a recurrence which involved both sides of the organ, and submitted to total laryngectomy. (See Case VIII of laryngectomy.)

The technic followed in these cases has been practically the same, and was modelled upon that practiced by Butlin and Semon. In my first case I undertook a preliminary tracheotomy. On the second day, however, there was a sharp rise of temperature, with cough and pains in the chest. The cannula was immediately removed and the symptoms subsided. A week later she was again tracheotomized and thyrotomy and removal carried out at the same time.

The anæsthetic has been chloroform in the majority of instances, although ether has been employed in a few later.

A median incision is made from the upper border of the thyroid to a point just above the suprasternal notch. The lower part of this is deepened and the trachea exposed. When all bleeding has been arrested, the trachea is opened and a sponge plug or tampon, to which has been tied a double loop of strong silk, placed in the upper segment of the air tube, the distal end of the silk loop clamped with an artery forcep and the cannula introduced. From this time the anæsthetic is administered through the tracheal cannula. The upper part of the incision is next carried down to the cartilage, the thyrohyoid membrane incised, and the thyroid, cricothyroid membrane, and occasionally the cricoid cartilage, divided in the median line, freely exposing the laryngeal cavity. The two halves of the larynx are next widely retracted and the mucous membrane swabbed with a 4 per cent. solution of cocaine, or cocaine and adrenalin. If any doubt exists regarding the competence of the sponge tampon it is re-inforced by gauze packing from above, to prevent the possibility of blood entering the trachea. The growth is now examined and its extent appreciated. If the case is a suitable one for removal by this method, the tumor, together with a generous margin of healthy tissue, is removed down to the cartilage. Bleeding points are controlled by clamps and fine catgut, by the use of peroxide of hydrogen, or the small cautery point. In my earlier cases I packed the laryngeal cavity with one piece of fluff gauze after removal of the sponge tampon and any gauze employed for preliminary packing of the trachea. The packing was generally removed on the second day, the cannula on the third. Recently I have omitted the postoperative packing, and removed the cannula on the day following the operation.

The only case in which I have departed from the above outlined technic, is one in which I omitted the tracheal plug, but depended upon Rose's position to prevent blood from entering the trachea, and used a rectangular incision.

The personal experience of the writer in total laryngectomy is limited to eleven cases. Of these, five died as the result of the operation and six recovered. Of the six that survived the operation, one woman is alive and well ten years and three months from the date of her operation. One man is alive and free from recurrence three years and one month after operation. A third patient alive and well two years and four months. Of the other three, one died of pneumonia shortly after operation, one had a recurrence four months after his discharge from the hospital, and a third the most favorable case of the series, was free from recurrence when last seen, but since that time we have been unable to trace him.

Case I.—Colored woman, 42 years of age. Had what was supposed to be a small non-infiltrating papilloma removed from her left vocal cord in the summer of 1898 by Dr. F. C. Ard of

Plainfield. He kept the specimen, but felt so sure of its benign nature, that he did not have it examined microscopically. Six months later she returned with a small recurrence. He then had the original growth examined. It was pronounced epithelioma by the pathologist of the Presbyterian Hospital. Case referred to the writer for thyrotomy; this was done on November 24, 1898 (see Case I, thyrotomy series).

In February, 1899, I received a hasty summons to the Muhlenberg Hospital in Plainfield to see the patient, who was suffering extreme dyspnœa. On laryngoscopic examination, nearly the entire interior of the larynx was found to be filled with recurrent growth. She was offered the choice of a tracheotomy with temporary relief, or of total laryngectomy with a possibility of radical cure. She eagerly accepted the latter. Under chloroform and oxygen anæsthesia, after a low tracheotomy and plugging the upper segment of the trachea, the larynx was exposed and dissected from the surrounding soft parts. Both superior thyroid arteries were secured near their orifices, the superior laryngeal nerves divided and the lymph-nodes and lymph-bearing areolar tissue in the neighborhood removed. The trachea was next divided about the first ring, and the larynx separated from the œsophagus, and finally removed by cutting through the thyrohyoid membranes. The pharyngeal wound was closed with two layers of silk, the tracheal cannula left in place, the wound partly united and packed with gauze.

A moderate reaction followed the operation. Water was swallowed the fourth day. On the fifth day, as a result of a violent paroxysm of coughing, the pharyngeal wound opened. In other respects she continued to do well, and was discharged from the hospital four weeks later. She was shown to this Section on March 22, 1899, by Dr. F. C. Ard. She is still alive and well, ten years and three months having elapsed since the operation.

Case II.—A man, 51 years of age, suffered from cough and hoarseness for ten months. Referred to the Roosevelt Hospital by the laryngological department of the Vanderbilt Clinic, with diagnosis of carcinoma. Preliminary tracheotomy December 17, 1901, total laryngectomy two days later. Death from sepsis extending to mediastinum, and inhalation pneumonia on the tenth day.

The writer was strongly impressed that the preliminary tracheotomy was a mistake in judgment in this case, as considerable reaction and cough followed, which had not entirely subsided in the two days which had elapsed since the first operation. We resolved not to employ it in the future, but to employ the same technic which was carried out in the first case.

Case III.—A middle-aged man was referred to the writer in the autumn of 1902, suffering from cough, loss of voice and dyspnœa on exertion. The duration of the symptoms is not mentioned in my notes, but the disease was well advanced, and considerable loss of bodily weight and strength had occurred. The case was seen by a number of laryngologists, all of whom confirmed the diagnosis of epithelioma.

Under chloroform anæsthesia, total laryngectomy was carried out by the same technic as in Case I. Very little reaction followed the operation. The wound was dressed daily, and the amount of infection was trivial. He took water on the second day, and sat up in bed on the third. A leak occurred in the pharyngeal wound, and he was thereafter fed through a tube. He left his bed on the tenth day, and three or four days later was presented to my class as an example of a successful laryngectomy, although a small pharyngeal fistula was still present. A day or two later he passed the entire afternoon in the open air, and in the evening had a chill and rapid rise of temperature. Lobar pneumonia developed, and he died in three days.

Case IV.—Male, aged 65, with advanced disease. Operated upon at the Roosevelt Hospital on May 6, 1903. The same technic was followed as in the last case. Pneumonia developed almost immediately, and death followed on the fifteenth day.

Case V.—A healthy Adirondack guide about 45 years of age, was admitted to the hospital suffering from extensive intrinsic disease, involving both sides of the larynx. My notes in this case are defective, but I remember distinctly regarding him as a particularly good operative risk, in spite of the rather advanced stage of the disease. He was operated upon in the same manner as the last two cases. There was no shock and he showed no untoward symptoms for 24 hours. On the second or third day he developed pneumonia and died.

Reviewing my results up to this period, it will be seen that of five patients, only two recovered from the immediate effects of the operation, and only one remained well. All died of pneumonia: a death rate of 60 per cent. About this time I became interested in the remarkable results obtained by Gluck of Berlin, he having reported a series of 22 total laryngectomies, with but one operative death. Feeling, as I did, that my unfortunate results were due to technical errors, I resolved to visit Berlin and see Gluck's work. I was cordially received, and as a result of my observations found that his method differed from the one I had employed in several particulars. He employs no preliminary tracheotomy; he uses the Trendelenberg posture; he exposes the region by a rectangular cutaneous flap. He first opens the air passage from above, through the thyrohyoid membrane, and then removes the larynx from above downward; he draws the trachea outward from its bed, and attaches it to the cutaneous wound just above the sternal notch; he immediately introduces a feeding tube through the nostril into the stomach, and administers food at an early period. He also employs more generous tamponade of the wound, using iodoform gauze.

In following the after treatment of some of his cases, I observed no pneumonia and no evidence even of marked tracheal irritation. Patients were given an abundance of food as soon as they could retain and digest it. This to me appeared a most important factor, as the painful deglutition and fear of leakage from the pharyngeal wound had kept my patients on a very limited diet for many days; and as the patients are for the most part old and feeble, with little resistance, the question of adequate nourishment seemed an important one. I returned home full of enthusiasm, resolved to carry out Gluck's technic to the letter. Two cases presented themselves shortly after my return, both, however, with advanced disease.

Case VI.—A man, aged 43, who had suffered from hoarseness and pain for two years. He also had progressive difficulty in swallowing, and a loss of 40 pounds in weight. Laryngoscopic examination revealed an ulcerating epithelioma involving the superior aperture of the larynx.

Case VII.—Also had extensive disease, but was otherwise in fair general condition.

Both of these patients were operated upon in the same manner, and the technic of Gluck was carried out to the letter. The postoperative course was similar in each instance. Neither suffered appreciably from shock. Both cases, however, quickly developed a peritracheal infection, favored in my judgment by drawing the trachea from its bed and opening up the deep cellular planes of the neck. Case VI, whose resistance was low, quickly succumbed to pneumonia and acute mediastinitis. Case VII, whose resistance was greater, continued his uphill fight against sepsis for a number of days, but at last died of acute mediastinal cellulitis and pneumonia. In the latter case the trachea quickly became detached from the skin and retracted below the upper border of the sternum, where it lay in a mass of necrotic tissue.

The result in these two cases was disappointing in the extreme. In reviewing the several steps of the operation I was convinced that there was no advantage in the rectangular flap, that the removal of the larynx from above downward presented more technical difficulties than from below upward, and in my hands resulted in a larger pharyngeal wound with greater risk of leakage and subsequent infection. I was absolutely convinced, also, that the plan of stripping the trachea from its bed was unwise, as it opened up the deep cellular planes of the neck to the always present and unavoidable infection from the tracheal secretions, and from any subsequent leakage which might occur from the pharynx.

I resolved, thereafter, to perform a preliminary tracheotomy at least ten days before removal of the larynx. At this operation I would also, as suggested by Crile, divide the isthmus of thyroid, expose the trachea for a considerable distance above the tracheal opening, and by means of iodoform gauze packing create an area of granulation tissue around the trachea which would prevent subsequent retraction and offer an effectual barrier against infection travelling downward in the peritracheal tissues. At the secondary operation I would not attempt to raise the trachea from its bed in order to stitch its lumen to the skin, but, as suggested by Koschier, would content myself with destroying with cautery its mucous membrane above the cannula, and by frequently repeated packing prevent the entrance of wound secretions, both during the operation and during the subsequent dressings. This plan has been followed in the four operations I have performed since that time. In addition I have introduced the nasal stomach tube at the time of operation, and kept in place from 7 to 10 days, feeding the patients as soon as possible after operation. By following this plan I am able to report that all of the four patients made satisfactory recoveries. A brief résumé of each may not be out of place.

CASE VIII.—A laborer, aged 55 years, was admitted to the Roosevelt Hospital in May, 1906, suffering from recurrent carcinoma (see thyrotomy series, Case VII). Laryngoscopic examination showed a bilateral epitheliomatous growth. Preliminary tracheotomy and packing of wound. At the secondary operation the larynx was removed from below upward, the tracheal stump being left in place and securely packed. Patient made a satisfactory recovery, and was discharged in about four weeks.

CASE IX.—A female, aged 30, suffered for seventeen months from hoarseness, and a slight pain on left side of throat for two months. Laryngoscopic examination showed intrinsic growth situated on left cord and extending slightly to the right of median line. Diagnosis confirmed by microscopic examination of fragment. Preliminary tracheotomy in the manner above described. Twenty-three days later total laryngectomy under colonic anæsthesia. Smooth convalescence. Discharged on the twenty-eighth day.

CASE X.—The history of this case has been lost. Patient admitted to the hospital in moderately severe dyspnœa with extensive carcinomatous growth. Preliminary tracheotomy under chloroform. Secondary removal of larynx under colonic anæsthesia ten days later. Early feeding through nasal tube. Convalescence was uneventful. Six months later patient returned with recurrence in the tissues of the neck and was referred to the Department of Charities for future care.

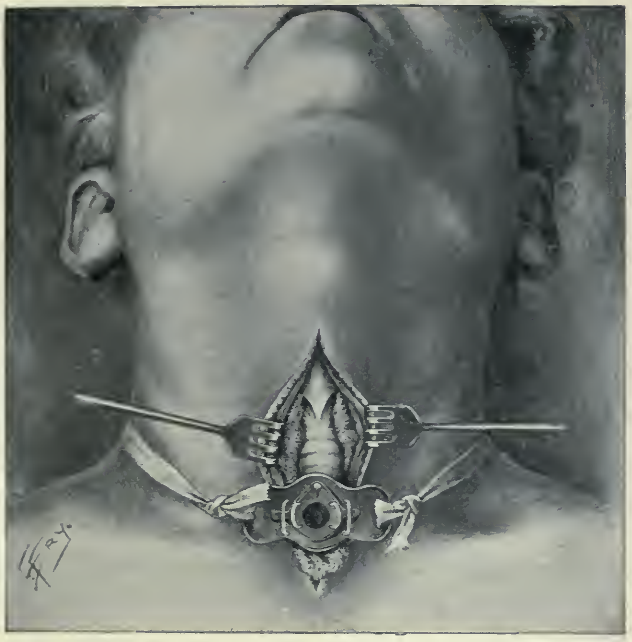
CASE XI.—The history of this case has already been reported by Dr. Harmon Smith, by whom he was referred to the writer. Briefly, the history was of tumor of the larynx of ten years duration. The tumor involved the left vocal cord and adjacent structures. Microscopic examination of a fragment removed by Dr. Jonathan Wright showed undoubted malignancy. Pheliminary tracheotomy followed in fourteen days by total laryngectomy. Convalescence was rapid and uneventful. When last seen, five months after operation, there was no sign of recurrence. Since that time we have been unable to trace him, and his present condition is therefore unknown.

The rapid and satisfactory convalescence which occurred in the last four cases contrasts so strikingly with the results which followed my earlier operations that one is strongly inclined to the opinion that it must be due to the changed technic. While I lost one case of my earlier series in which I performed a preliminary tracheotomy, it must be remembered that I allowed only two days to intervene between it and the secondary operation,—a period far too short in which to establish a successful granulation barrier against peritracheal infection.

To recapitulate, my technic in total laryngectomy is:

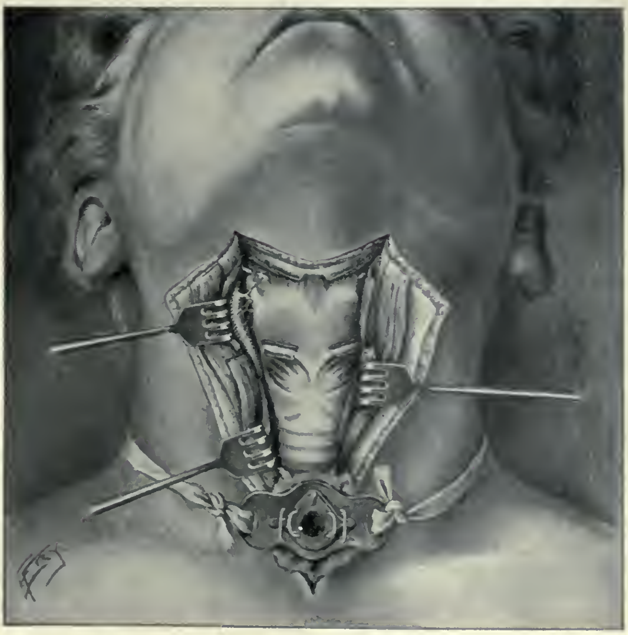
Under general anæsthesia, after the usual local preparation, a median incision is made extending from the cricoid to the sternal notch. The muscles are separated, exposing the isthmus of the thyroid, which is double ligated and divided. The separated edges are pushed to each side and the trachea freely exposed. A low tracheotomy is then performed and the cannula introduced, after which the upper part of the incision is united with silkworm gut sutures, and the peritracheal space generously packed with iodoform gauze both above and below the cannula (Fig. 1). The wound is dressed and the patient placed under a tracheotomy tent into which a small amount of steam is introduced by means of a croup kettle. The external opening of the tracheal cannula is constantly covered with four or five layers of gauze wet in warm boric acid solution, with a view of filtering the air which enters the

Fig. 1.



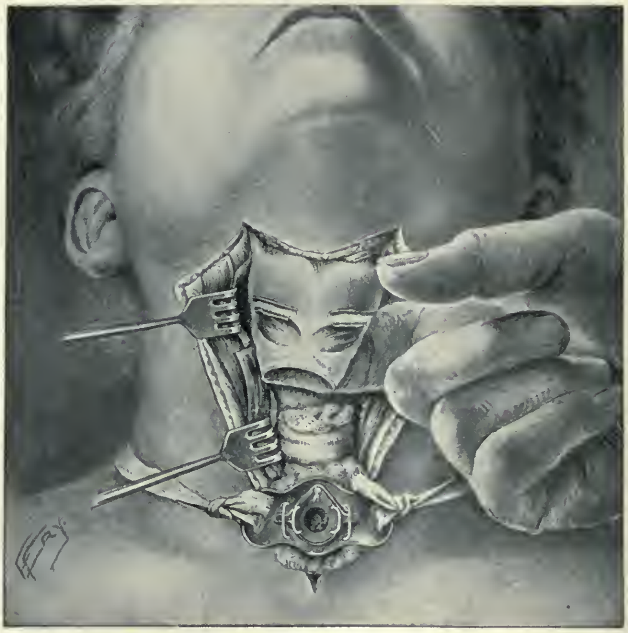
Preliminary tracheotomy with peritracheal tamponade.

Fig. 2.



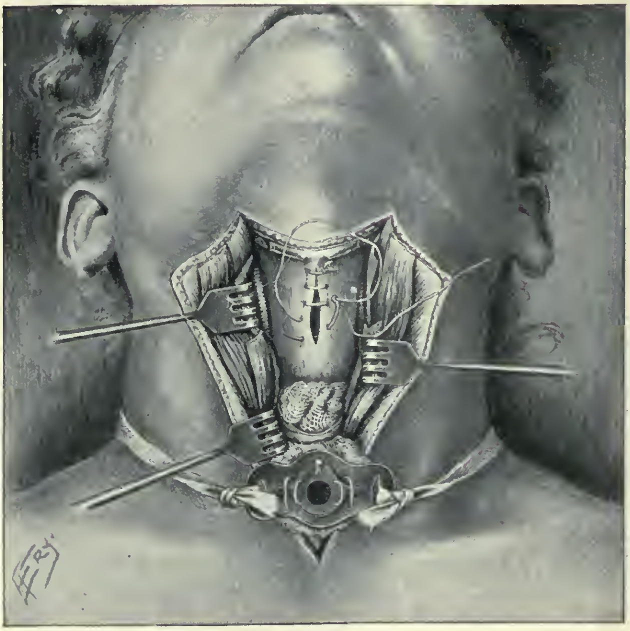
Exposure of the larynx and thyrohyoid membrane

FIG. 3.



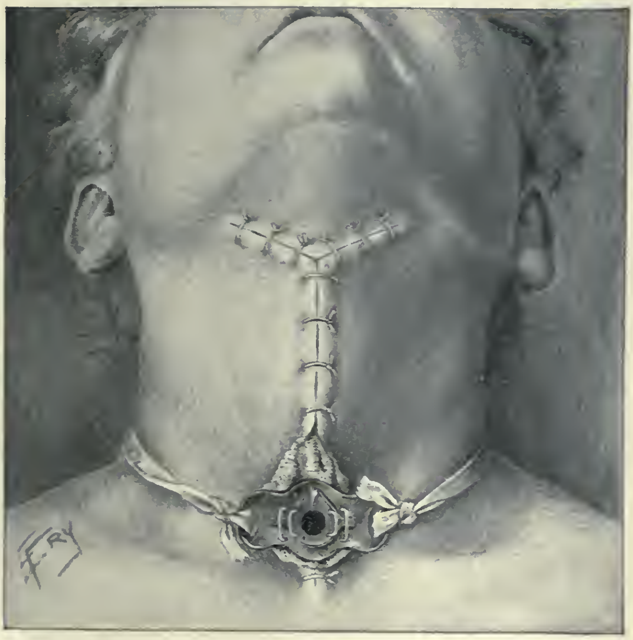
Division of the trachea, and separation of the larynx from the œsophagus.

FIG. 4.



Suture of the pharyngeal wound, and packing the upper segment of trachea.

FIG. 5.



Wound closed, with generous gauze packing about tracheal stump.

trachea. A special day and night nurse attends the patient. About ten days after the preliminary operation, if the patient has a normal temperature and is not suffering from cough and excessive tracheal secretion, the secondary operation is undertaken.

Chloroform is administered through the tube until the patient is anæsthetized, after which its administration is continued in the same manner, or colonic etherization is employed by means of the Sutton apparatus. The use of scopolamine 1/100 gr. and of morphine 1/6 gr. one-half hour before operation is a decided advantage in these cases, as it not only diminishes to a considerable extent the amount of anæsthetic required, but lessens the post operative vomiting, and insures a period of from one to four hours of freedom from restlessness after the operation, a period when most laryngeal cases are coughing and vomiting, and increasing thereby the always present tracheal irritation.

The patient is placed on a flat table with the head well extended. An incision is made from the body of the hyoid downward to the upper limit of the former cut. From the upper extremity of this incision two lateral incisions are made in an upward and outward direction extending to the anterior borders of the sternomastoid muscles. The two triangular flaps are turned outwards, the sternohyoid muscles divided just below their attachment and the sternothyroids detached from the cartilage (Fig. 2). The two superior thyroid arteries are next located and ligated. The superior laryngeal nerves are cut and all lymph-nodes and neighboring lymph-bearing areolar tissues are removed. The attachments of the inferior constrictors are next divided and posterior surface of cricoid partly separated from the œsophagus by blunt dissection.

When the larynx is thoroughly skeletonized, the tracea is severed just below the cricoid, and its distal extremity immediately packed tightly with gauze, completely preventing the entrance of blood or pharyngeal mucus. The forefinger of the left hand is next introduced into the upper or laryngeal segment of the tube, and the larynx gently raised from the œsophagus, any remaining attachments being separated by gauze sponges (Fig. 3). When the larynx is thus completely separated from the œsophagus, the tips of the thyroid cornua are divided, the thyrohyoid membrane incised and the larynx removed.

The pharyngeal wound is then packed with gauze to prevent excessive contamination of the wound, and the parts carefully inspected for evidences of remaining disease. The oval pharyngeal wound is next tightly closed by two layers of suture, the first of plain catgut, the second of chromic catgut (Fig. 4). After closure of the pharyngeal opening, the entire upper wound is temporarily packed with wet formalin gauze, while the tracheal stump is prepared for closure. This is accomplished by removing redundant tissue above the cannula opening, dissecting out or destroying with cautery the mucous membrane, and packing firmly with iodoform gauze above the tube. A No. 30 F. rubber feeding tube is then introduced through the left nostril into the œsophagus, and secured by a safety pin and plaster straps to the face. The wounds are next united above, with generous gauze packing about the tube (Fig. 5.)

The after-treatment is the same as following the preliminary tracheotomy. Water is given through the tube as early as the morning following the operation, if there is no nausea. Milk, coffee, egg nogg, meat juice, and soups follow as soon as possible. No attempt at swallowing should be made for at least seven days, after which the tube can be removed. The wound should be dressed at least once every day, and two or three times if there is infection or pharyngeal leakage. The tracheal stump is quickly covered with granulations, and gives no trouble. The patients continue with the silver cannula.

THE CLOSURE OF THE WOUND AFTER THE RADICAL AMPUTATION OF THE BREAST.

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OF NEW YORK,
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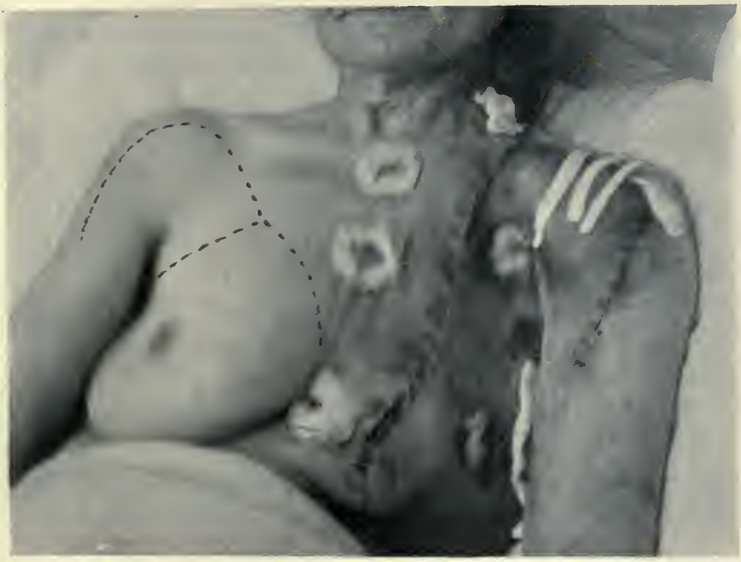
HAVING recently had occasion to do three radical amputations of the breast for carcinoma within twenty-four hours, the method of closing the extensive wound was brought up for discussion by one of the assistants, who expressed surprise at the method I employed. The method is the one I have used in all my cases, with slight modifications, during the past ten years. To quote from an article by J. C. Warren of Boston: "The closure of the wound in this operation has always been a difficult problem, since it has been decided that the whole integument of the breast should be included between the incisions. Any method which permits of an easy approximation of the edges of the wound is out of date. The method of grafting adds materially to the length of the operation and leaves a most unsightly scar. The removal of the breast is at best a demoralizing ordeal to most patients, and every effort should be made to procure as rapid healing and as little unsightly a cicatrix as possible." Halsted, on the other hand, says: "To attempt to close the breast wound more or less regularly by any plastic method is hazardous and, in my opinion, to be vigorously discountenanced. The oval flap, whatever the direction of its long axis, removes, so far as the cure of the disease is concerned, a circle of skin whose diameter is not greater than the short axis of the oval. I still believe in the removal of a very large circle of skin and endorse the remark of my ex-house surgeon, Dr. Follis, that the operator whose duty it is to close the wound should not be entrusted with the planning of the skin incision." Halsted acknowledges that the grafting does interfere with very early arm movements.

The two opinions quoted above represent fairly well the diverging views still held in regard to closure of the wound after the radical operation. We believe the opposing views can be harmonized. No one will gainsay that a grafted area after breast amputation tends to form an unsightly scar. I have seen such scars months later, and they are not things of beauty. On the other hand, it will be said that we are not doing a cosmetic operation, but a deliberately mutilating operation designed to permanently cure an extensive carcinoma. Perfectly true; just as it is perfectly true that a large circle of skin should be removed with the breast. But are we justified in concluding from these premises that we must use grafts to cover such an area, that we must unnecessarily prolong the length of the operation, that a plastic operation is to be deprecated and that our unfortunate patient must carry around a most disagreeable scar? Such would seem to be the conclusions of those who, as a routine procedure, without attempting to close the wound completely, regularly use skin grafts in every operation of this kind. The writer rather tends to agree with the views of Warren, that the removal of the breast is a sufficiently demoralizing ordeal to warrant our making every effort, *consistent with the safety of our patient,* to bring about a speedy recovery with the best possible cosmetic result. In so doing we would not save the smallest piece of skin that we thought ought to be removed with the tumor. We believe in and practice a very wide excision of skin, together with breast, tumor, pectoral muscles and lymphatics. We do not allow ourselves to be influenced, when making the original incision, by any fear that we may not be able to subsequently close the wound. Our excision of skin is just as extensive as that practiced by those who graft in every case. It has frequently happened to the writer that an assistant or onlooker has expressed the opinion that it would be impossible to close the enormous wound without grafting. And yet during the ten years that we have practiced the radical operation we have in every case been able to cover the denuded area by transplanting the breast from the oppo-

FIG. 1.



First dressing after radical amputation of breast, six days subsequent to operation. The right breast before operation was almost in the axillary line. At the completion of the operation part of the breast overlapped the median line,—it has already been somewhat drawn back to the right side. Note distance of shot and plate sutures from edges of incision. Note supraclavicular drain emerging from stab wound.

The dotted line represents the usual incision,—it is carried around the lower border of the breast in the shape of an ellipse.

site side. No one, we believe, will deny that if we are able to close the wound in this way the resulting linear scar will be far more pleasing to the patient than a broad grafted area. Quite recently a private patient, an unmarried lady of 39, on whom the writer had performed this operation over six years ago, presented herself for observation. The wound had healed by primary union and the resultant linear scar was scarcely noticeable.

The incision is represented by the dotted lines in the illustration (Fig. 1). If the supraclavicular glands are to be removed through the same incision then the racquet-shaped incision rises more vertically upward towards the clavicle. In some cases these glands are removed through a separate incision. We always remove both pectoral muscles *in toto*. We begin our dissection by dividing the tendon of the pectoralis major, then dissecting backwards, remove axillary contents with the muscles, tumor, and breast all in one piece. By undermining the opposite breast and using shot and plate sutures any defect can be completely covered. The opposite breast is usually flabby and there is much redundant skin, so that the technical difficulties are usually not great. In several cases the nipple of the opposite breast at the end of the operation was in the median line; some part of the opposite breast regularly overlaps the median line. But so great is the elasticity of the skin that in a few weeks the breast has returned almost to its normal position. Furthermore, in many cases, the breast will be so flabby and pendulous that the nipple is almost in the axillary line before we begin our suturing. In such cases, at the end of a few weeks the breast will be found in a perfectly normal position, in spite of the fact that it was drawn over to the opposite side to cover the defect.

In mobilizing the breast a few free incisions are made behind the breast, the edges of the incision being forcibly pulled away from the chest wall. Much of this dissection can be done bluntly; a few vessels require ligation. The dissection, blunt or sharp, proceeds between the posterior surface of the breast and the fascia covering the pectoralis major.

The fascia itself should not be injured, but the loose areolar tissue between this fascia and the breast should be divided. This can be done in a few minutes; and the skin flap towards the axilla on the affected side, where the dissection has already been done, is freed as far out as possible. This should be especially thoroughly done at the lower angle of the wound, as it is near the lower end of the denuded area that most tension is usually encountered in passing the sutures. Two assistants now forcibly adapt the margins of the wound, and the amount of tension can then be readily ascertained. If necessary, the skin can be mobilized in a similar manner below the lower border of the incision; we have done this in most of our cases and it has helped us to close some wounds which we would otherwise have been unable to close. In one case where on account of the size of the tumor an unusual amount of skin had to be sacrificed, after mobilizing the opposite breast, we made two horizontal incisions, one above and one below the breast, and we were then able to bring (slide) the breast well over to the opposite side and thus close the enormous defect. But this procedure will rarely be necessary. It is really surprising how readily the usual defect can be covered by the above method. We use two or three shot-and-plate sutures and are careful to place them two and a half or three inches from the margins of the wound on each side. Since using a small thick pad of gauze between the lead plate and the skin, we no longer see the little area of necrosis due to pressure of the plate against the skin. Heavy silkworm is used for this suture, a perforated lead bullet is fastened to the end of the suture, then comes the perforated lead plate with edges slightly turned up away from the skin. The free end of the suture to which the needle has been added, is passed through the centre of the small gauze pad. This pad should overlap the edges of the lead plate at least a quarter of an inch all around. The needle is then passed through both skin flaps at some distance from the edges. Without unthreading the needle, it is passed through a second gauze pad which is pulled down close to the skin. The needle is then removed and the silkworm suture passed through the lead plate and lastly through the perforated bullet. An artery forceps is placed on the end of the suture and the other tension sutures are passed in a similar manner. These sutures are prepared before the operation, and take but a minute to apply. An assistant forcibly approximates the edges of the wound by crowding the breast over towards the affected side. The operator quickly adjusts the shot-and-plate sutures, and a running suture of fine silk accurately brings together the edges of the skin. The arm and shoulder portions of the incision can be partly approximated with strips of Z. O. plaster. Drainage is provided for in the usual manner by a tube introduced through a stab opening low down in the posterior axillary line. If the supraclavicular glands have been removed without making a separate skin incision, this space is drained through a small opening in the skin above the clavicle. The first dressing is done on the sixth or seventh day and all sutures are then usually removed. After removing the sutures we are accustomed to keep the skin edges approximated with numerous strips of Z. O. plaster.

This simple method of wound closure has been so satisfactory in our hands, and so gratifying to our patients, that we feel justified in recommending it to others.

THE POSTOPERATIVE TREATMENT IN CASES OF TYPHOID PERFORATION.

REPORT OF FOUR CONSECUTIVE CASES OPERATED UPON WITH RECOVERY.

BY PEREGRINE WROTH, Jr., M.D.,
OF HAGERSTOWN, MD.

DURING my term as Resident Surgeon at the Union Protestant Infirmary of Baltimore, 1907–1908, I had the opportunity of caring for four cases of typhoid perforation. After having operated on these cases I was able to employ the so-called Fowler-Murphy treatment of peritonitis with the result that all four cases recovered.

The object of this paper is to call attention to the modified Fowler-Murphy treatment of general peritonitis as applied to the peritonitis following the perforation of typhoid ulcers, emphasizing the fact that under such conditions the primary disease may be disregarded almost with impunity and the patient placed in an upright position and kept there for days, if need be, without experiencing any ill effects.

Previous reports have laid stress on the need for drainage, but have regarded the patient as still demanding rest in the recumbent position and have relied on flank incisions to secure drainage by gravity.

The four cases on which I operated in the summer of 1908, all of which recovered, were set bolt upright in bed immediately after operation and given salt solution continuously, by rectum.

Symptoms.—It is not my intention, here, to discuss the symptoms following the perforation of a typhoid ulcer, nor the physical signs by which such perforation may be recognized. It will be interesting, however, to note a few points shown in this series. By all odds the most important and the most constant symptom is abdominal pain, " sudden, sharp, severe." As characteristic as its suddenness and severity is its paroxysmal nature. In the cases under discussion this point was well shown; in no one of them was the pain constant, in three of them the patients went to sleep after the first paroxysm. One of them, a little girl of six years, went to sleep after her first complaint before the house doctor could be called and slept peacefully for three hours. Another, a nervous, almost hysterical man, slept one and a half hours between pains, and a third, a boy who filled the ward with his cries at first, slept brokenly a good part of the time between the making of the diagnosis and his transfer to the operating room. The severity of the pain, at least in these cases, made it quite evident that there was something unusual going on, though three of the cases were in children, all of whom had complained of more or less pain throughout the course of the disease. One boy, by the urgency of his complaints, had alarmed us many times, and we had come to regard him as a chronic grumbler; but when finally he did come to experience the pain attending an actual perforation, there could be no doubt that at last his suffering was real. In this short series, sudden, sharp, severe abdominal pain, coming in paroxysms, was the only constant symptom.

Signs.—In all these cases the characteristic signs of tenderness, rigidity, and spasm were present, but in varying degree. Distention was present in only one, and then was not marked. The presence or absence of movable dulness in the flanks was not noted. One sign, to which by most authorities very little importance is attached, was present in three of the four, and its absence in the fourth was fully explained on opening the abdomen; I refer to the rapid and complete disappearance of liver dulness while there was no or very slight abdominal distention. The study of this sign in the series under consideration, and in three other cases which have come under my observation, tempts me to speak strongly of its value as positive evidence, at least, of gas free in the peritoneal cavity—a condition which, arising in the course of typhoid fever, points in almost every case to the perforation of an ulcer; and even in the few cases in which the gas does not owe its presence to a perforation, the indication for exploratory laparotomy is absolute. In three of the cases there was a rapid and absolute disappearance of liver dulness while there was no abdominal distention. In the fourth case the liver dulness was not diminished but the diagnosis of perforation was made on other grounds. At operation in this case there was no evidence of gas escaping when the peritoneum was nicked; there were no bubbles seen when the intestine was drawn up; there was no free fluid; there was, at first sight, practically no evidence of peritonitis. Finally, however, a piece of omentum was pushed back and there occurred a rush of bubbling, yellow fluid; and a perforation in the ileum, until this covered loosely by omentum, was revealed. In this manner the persistence of liver dulness was explained.

In connection with this point I wish to refer to three cases, not of this series, which came under my observation during my residence at the Union Protestant Infirmary:

(I) A case of a woman with typhoid fever in whom a perforation was suspected on account of pain, tenderness, rigidity, and extreme abdominal distention. Notwithstanding a marked distention of the abdominal walls, there still remained, on percussion, about one and a half inches of liver dulness. A laparotomy was done, no sign of perforation was found, and an uneventful recovery ensued. (II) A typhoid fever patient, complaining of some slight general abdominal pain, who on examination showed no signs definitely pointing to perforation, but with a non-distended abdomen there was complete disappearance of liver dulness. Operation disclosed no perforation (nor at autopsy did closest search of gut from rectum to stomach reveal any); but as the peritoneum was nicked there was a stream of escaping gas, which was plainly felt in the face of the operator. In the right iliac fossa there was a collection of pus; the cæcum and lower part of the ileum was thickened, red, and covered with fibrinous exudate. The appendix and gall-bladder were normal. There probably had been a peritonitis set up through the almost gangrenous walls of the cæcum and ileum, possibly through some perforation too small to be evident to the naked eye. In this case the determining factor in the question of operation was the absence of liver dulness with a non-distended abdomen, no other signs being definite enough to signify the necessity for surgical interference. (III) A case seen several years ago, brought in with a diagnosis of typhoid fever. There was a rapid disappearance of liver dulness followed by an extreme distention of the abdominal walls; and though the patient was perfectly conscious, he complained of no pain, nor could we at any time elicit any tenderness nor make out any spasm or rigidity of the abdominal walls. Death occurred in a few days; and when the balloon-shaped abdomen was opened at autopsy, there was an outrush of gas and a complete collapse of the walls. The intestines were found absolutely collapsed, lying against the posterior wall of the abdomen, bathed in pus. A perforation admitting the thumb was found at the junction of the cæcum and ileum. In this last case the belief that the obliteration of liver dulness with a *distended* abdomen was of no diagnostic importance prevented an exploratory incision.

The evidence of these cases seems to me to show: (1) in a *scaphoid or non-distended abdomen* the obliteration of liver dulness is extremely suggestive of free gas in the peritoneal cavity; (2) in a *distended abdomen* it is a sign which is extremely suspicious; (3) the *non*-disappearance of liver dulness in an abdomen even when enormously distended gives good ground (unless other signs are very definite) for the belief that the intestinal tract is not the seat of a perforation.

In order to avoid repetition it will be better at this point to indicate the routine treatment of the cases of this series, before perforation, and also give in some detail the postoperative treatment.

Treatment Before Operation.—Each case of suspected typhoid was isolated on admission. The temperature, pulse, and respiration were observed and noted every three hours. The diet consisted of the albumin of two eggs in four ounces of water, slightly flavored with orange or lemon juice, alternating every three hours with four ounces of milk to which was added two ounces of lime-water. Every three hours, while temperature was 102.5° F. or over, a sponge bath with water ranging from 80° F. to 90° F., lasting twenty minutes, was given. No cathartics were used, but every second day, if necessary, an enema of 500 c.c. of soap suds was administered. Water was given freely as desired, and if need be was forced upon the patient. During the night, unless the temperature was running very high, the patient was allowed to sleep for one period of six hours without being disturbed for temperature taking or nourishment. In the case of children these same measures were carried out with slight variations, the diet being changed so that there was the albumin of one egg in a nourishment instead of two, and the sponge bath lasting for fifteen minutes instead of twenty.

Postoperative Treatment.—The general course of treatment after operation, allowing, of course, for a few unavoidable minor differences, was the same in the four cases. In the first place the patient on returning to bed from the operating room was placed as nearly bolt upright as was compatible with comfort and strength. In all these cases the patients were able to maintain the upright position more consistently than is the rule, and in no one of them were any untoward effects observed. This position was maintained uninterruptedly in all for at least four days, and in two instances the patients, seeming more comfortable in this position, were allowed to sit bolt upright for a week.

As soon as the patient had been placed in an upright posture the continuous administration of salt solution per rectum was begun. The apparatus used was one devised by myself for the purpose. It consisted of a metal frame holding a glass infusion flask and a glass funnel. The salt solution, controlled by a stopcock, was allowed to flow, one drop at a time at a fixed rate, from the flask into the glass funnel. By means of the stopcock the rate of flow could be regulated with a considerable degree of exactness. From the funnel the salt solution was conducted to the rectum through a long rubber tube terminating in a very fine rubber catheter. The salt solution was kept at the proper temperature by passing the conducting tube between two hot-water bags laid on a stand beside the bed. By means of this apparatus the majority of patients can be given from two to six litres of salt solution per day for a week, without causing them any inconvenience, and with the loss of very little salt solution.

The drainage from the wound was profuse at the start, and at first resembled the fluid found in the peritoneal cavity at operation; but the character changed in from twelve to thirty-six hours so that finally the drainage was much less in amount and perfectly clear, hardly staining the dressings. In one case where a rubber tube was used to drain the pelvis the fluid flowing therefrom by the end of the second day could not be distinguished from the clear salt solution being introduced into the rectum. As long as the drainage was profuse the dressings were changed every four to six hours; but as it became less in amount, the dressings were changed at much longer intervals. The drains themselves were removed just as soon as it was thought their purpose had been fulfilled. When there were two drains, one of them at least was removed at the end of twenty-four hours. If the patient's condition demanded stimulation, strong, black coffee, first filtered, was mixed with the salt solution in the proportion of 400 c.c. of coffee to 600 c.c. of salt solution, and this mixture given for twelve hours at a time. In one case in which the continuous rectal administration of fluid was not successful, salt solution and coffee were given in smaller amounts every three or four hours. As soon as the patient was conscious,[1] fluid was given by mouth in small quantities, rapidly increasing to full liquid diet. As soon as the temperature became normal the patient was given soft-boiled eggs and the diet then rapidly increased until solid food was taken.

These patients were fed a little more rapidly than was our custom in the feeding of typhoid-fever patients, a quick return to normal body-weight and strength being especially desired.

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[1] In practically none of the cases of peritonitis that I have seen treated by the Fowler-Murphy method at the Union Protestant Infirmary and elsewhere has there been any postoperative nausea while the patient was in the upright position.

REPORT OF CASES.

CASE I.—L. R.; female; white; aged 8½ years. This patient was admitted to the hospital on July 15, 1908, in what was probably her third week of typhoid fever. She showed a pretty severe type of the disease, being irrational part of the time. On July 17 and 18 there was slight bleeding from the nose. On July 19 patient had a small hemorrhage from the bowel. Immediately all nourishment was discontinued, and water restricted to two drachms every two hours. Small doses of paregoric were given, and large doses of calcium lactate. The patient was not allowed to be turned; and ice packs, given with the patient flat on her back, were substituted for baths. On July 21, forty-eight hours after the hemorrhage was observed, there having been no other signs of bleeding, water by mouth was allowed. At 12.45 P.M. of that day the patient complained of severe abdominal pain chiefly on left side about the level of the umbilicus. On examination, one hour later, the abdomen appeared slightly full but not distended; was held rigidly everywhere; was very tender wherever touched; and the liver dulness, heretofore extending an inch below the costal margin, entirely disappeared; leucocytes had risen from 5000 to 10,000. The diagnosis of perforation was made, but on account of difficulty in establishing communication with the family, a delay of four hours occurred before the operation could be performed. At 2.30 P.M. the patient had small, brown, fluid stool. At 2.45 P.M. she vomited a large amount of yellowish fluid. The pulse up to noon had averaged about 100; but from the time the patient first complained of pain it rose rapidly to 122 then to 128. The temperature at 12 M. was 100.6° F. At 3.00 P.M. it was 103.9° F. Respirations remained unchanged. At 4.45 P.M., four hours after the patient had first complained, she was taken to the operating room.

Operation.—Anæsthetic: ether. Time of operation: twenty-five minutes. Low right rectus incision. Abdomen found full of clear yellow fluid without odor. Cæcum located; ileum followed up; perforation admitting a lead-pencil found ten inches from ileocæcal valve; perforation closed by purse-string suture of fine black silk, reinforced by two mattress and two Lembert sutures of the same material. Two large cigarette drains were laid through lower angle of incision to bottom of pelvis. No drain laid to site of perforation. Wound closed with catgut.

Patient was returned to bed; placed in upright position; continuous salt solution per rectum was started. The day following the operation the patient was allowed water in small quantities; dressings were changed frequently, well soaked. By the third day the drainage was clear but still large in amount. On fourth day patient was taken down from the upright position, and as the drainage had become much less in amount, one drain was removed from pelvis, second drain being removed day following. Patient's bowels were moving frequently, the salt solution acting as a low enema, and on the fifth day the administration of salt solution per rectum was stopped. Patient's condition after operation good; very little pain; no distention; pulse falling gradually; temperature running irregularly—at no time over 102.6° F. By July 27, one week after operation, patient was taking same diet as before operation. Sponge baths were resumed and the course of the disease was from that time on a typical typhoid convalescence. Patient was discharged on Sept. 16, temperature having been normal for almost a month; abdominal wound entirely healed.

An interesting point in this case was the fact that on account of slight hemorrhage on July 19, the patient had received nothing by mouth but water in small quantities for forty-eight hours prior to perforation. The early age of this patient (8½ years) is also of interest. It may be worthy of note that this patient had been ill at home for three or four weeks before coming to the hospital, and during this time had probably eaten without restriction.

Case II.—H. E.; male; white; aged 38 years. Admitted to the hospital Aug. 18, with typhoid fever. Course of disease uneventful except for severe cough which bothered patient considerably. Aug. 24, 3.00 A.M., patient expelled a great deal of flatus. At 5.30 A.M. he received an enema, 500 c.c. of soap suds, which was expelled with a great deal of flatus and a large fluid stool consisting for the most part of dark blood. From that time until noon patient was very comfortable. At noon he began to complain of sharp pain in lower abdomen. Abdomen was examined and found flat; liver dulness normal; tenderness was elicited only on deep pressure above symphysis and in inguinal regions. The pain was of the same character as that usually seen with a distended bladder. The character of the pain, its situation, the negative result of abdominal examination, and the fact that the patient, who up to this time had been voiding large amounts at intervals of thirty minutes, had not voided at all for one and a half hours, made it seem probable that the whole disturbance might be due to a distended bladder, though no bladder tumor could be made out. Hot-water bag was applied to lower abdomen and patient immediately went to sleep. One and a half hours later patient awoke and complained of abdominal pain of the same character as before. As he had not voided for four hours, he was catheterized, 300 c.c. of urine being obtained. He immediately became comfortable and remained quiet for one and a half hours. At the end of that time he complained again of pain as before, but examination was again negative. Patient was very much frightened, complained of tenderness wherever touched, all tenderness, however, disappearing whenever he regained his composure. At 6.00 P.M. patient had become much quieter and a much more satisfactory examination could be carried out. At this time tenderness could be made out over whole lower abdomen on light pressure. Abdomen was not at all distended, its walls were rigid; but this point was of no assistance as patient had persistently held his abdominal walls rigidly ever since admission. The liver dulness, however, had entirely disappeared. Pulse was fourteen beats higher than it had been for two days; temperature 103.5° F., which was slightly higher than it had been for several days past. On examination of the chest there were practically no breath sounds to be heard on left side. Percussion note was normal; leucocytes were 7500 in the A.M., the same in the P.M. Diagnosis of perforation was made, the absence of liver dulness with an abdomen not at all distended pointing definitely to the presence of free gas in the peritoneal cavity.

As soon as the consent of the patient's wife could be obtained, patient was taken to the operating room, eight hours after the first symptom of perforation had been observed.

Operation.—Anæsthetic: ether. Time of operation: forty minutes. Low right rectus incision. Peritoneum incised, allowing escape of yellow fluid and some gas. Cæcum located and ileum followed up from that point. About one foot above the cæcum were found four perforations; the first one oozing, the second large enough to admit a thumb, and freely draining intestinal contents. The two perforations above this one were both oozing yellow fluid and gas. The portion of gut containing perforations measured about eight inches. The peritoneal cavity was full of cloudy, brownish fluid and fecal material; the intestines everywhere red and injected. The three small perforations were closed with purse-string sutures of fine black silk, reinforced by mattress sutures of the same material. It was impossible to close the largest perforation because its closure would have encroached too markedly on the lumen of the gut. The intestine at the site of this perforation was drawn into the wound and packed around with iodoform gauze. The edges of the perforation were then sutured to the edges of the parietal peritoneum, the sutures passing through the gauze packing. A very small iodoform drain, reaching to the perforations situated above, was laid in the lower angle of the wound. A suprapubic incision was now made in the mid-line and through it two large cigarette drains and one rubber tube were laid to the bottom of the pelvis.

Patient returned to ward greatly shocked; was put to bed in the upright position; and the continuous administration of salt solution by rectum begun. Enterostomy was draining freely and as soon as patient recovered sufficiently, he was allowed full liquid diet. His condition for thirty-six hours after operation was extremely grave, but improved progressively on no other stimulation than salt solution and coffee per rectum. Two days after operation respiratory distress became marked, the frequency varying from twenty-eight to thirty-six per minute. Examination of chest showed a tympanitic note throughout left side with an entire absence of breath sounds. Cough was constant and expectoration free. When patient left the hospital, several months later, the left side of chest was still tympanitic and no breath sounds could be heard except at extreme upper portions; but this condition seemed not to embarrass the patient in the least. By the end of the first week condition had improved very much. All the original drains had been removed, and, except from the enterostomy itself, there was but little drainage of any sort.

In this case salt solution and coffee after the third day were administered in small quantities at intervals of three hours, the patient not having been able, after the third day, to retain the fluid when given continuously. Owing to the excoriation of the skin by the drainage from the enterostomy, the patient was placed in a continuous tub on the twelfth day and kept there for two weeks. Temperature was normal from the time he was placed in the tub. Several weeks later there was some rise of temperature due to numerous large abscesses over back and buttocks, but aside from this, patient's convalescence was uninterrupted. Three weeks after operation patient was taking solid food. Two months after perforation abdominal wounds had healed with the exception of a small fecal fistula at the site of enterostomy. Nov. 28, at a second operation, about six inches of gut were excised and a lateral anastomosis was done. Patient made uninterrupted recovery and went home on Jan. 4, 140 days after admission.

In this case we are confronted by the question as to the method of procedure in dealing with a perforation which cannot be closed, either on account of the friable condition of the edges or on account of its large size. The gut wall around the opening in this case was extremely friable; but even had it held, the lumen of the gut would have been so narrowed that obstruction would have been inevitable. The ideal method, and that usually advised, would be, then and there, to excise a portion of gut and to make an anastomosis. It seemed, however, in view of the grave condition of the patient and in view of the presence of a fierce general peritonitis, that the establishment of an enterostomy, while less desirable from many points of view than the procedure above referred to, was here the operation to be chosen.

Case III.—P. H.; female; aged 6 years. Patient admitted to the hospital with typhoid fever Aug. 21, 1908. Disease ran a typical course for a week after admission. Aug. 29, eight days after admission, 1.30 a.m., patient awoke complaining of pain in abdomen, but immediately went to sleep again. She was, however, awakened a few minutes later during the course of an abdominal examination. At this time there was no distention of abdomen, liver dulness reached costal margin. There was slight tenderness and slight resistance to deep palpation on right side. Leucocytes were 13,500 (12,000 two days previously). On conclusion of examination patient went to sleep and slept unbrokenly for three hours. At the end of this time she again awoke crying with pain in both sides of abdomen. Second examination showed abdomen to be slightly fuller, though not markedly distended. There was general tenderness on pressure, especially on the right side, where there was also definite rigidity. Liver dulness was not diminished; leucocytes 14,000. Diagnosis of perforation was made and as soon as the consent of the family could be obtained patient was taken to operating room, seven hours after the second attack of pain.

Operation.—Anæsthetic: ether. Time of operation: thirty minutes. Low right rectus incision; peritoneum incised; omentum presenting in wound appeared red and injected. There was, however, no free fluid seen, and no evidence of gas escaping from the intestine. On pushing back the omentum there was noticed the escape of bubbling, yellowish fluid. Cæcum was located, ileum followed up, and small perforation leaking intestinal contents found about one foot above cæcum. Perforation closed with purse-string suture of fine black silk, reinforced by mattress sutures of the same material. Two cigarette drains were laid to the bottom of the pelvis through the lower angle of the incision. One small strip of iodoform gauze was placed in the direction of the perforation. Incision closed with catgut. Patient was put to bed in the upright position. Continuous administration of salt solution per rectum was started. Liquid diet allowed on recovering consciousness. Condition from the first improved rapidly; temperature two weeks after operation dropped to normal and stayed there. About one week after operation the perforation apparently reopened, at least in part, and for a week there was a slight fecal discharge. This, however, ceased spontaneously, and recovery was otherwise uneventful. Patient left the hospital on the fifty-fifth day, sinus having been closed for several weeks.

It is interesting to note that in this case the liver dulness remained undiminished in spite of perforation in the intestine. This, however, was explained at operation, when it was found that the perforation was loosely covered by omentum. This case showed better than any other the intermittent or paroxysmal character of the pain as seen after perforation of a typhoid ulcer, the patient having slept unbrokenly for three hours after her first complaint. Perforation in typhoid fever at this age (six years) is rare.

In following out this line of treatment, there was not noted a single sign or symptom indicative of a bad effect on the course of the typhoid fever. On the other hand there was a very rapid subsidence of the peritonitis and a more rapid return to normal temperature and the stage of convalescence than was observed in the majority of our cases of typhoid uncomplicated by perforation.

Case IV.—T. H.; male; white; aged 12 years. This case came in with typhoid fever in about the second week of the disease. Course of the disease after admission was moderately severe. Patient complained frequently of abdominal pain after taking nourishment. There was nothing, however, abnormal made out any time on examination and most of the complaints were, after a time, put down to a grumbling disposition.

On Sept. 6, after having been comfortable all morning, sleeping part of the time, the patient awoke at 1.00 p.m., complaining of intense abdominal pain. He was seen immediately and his complaints were more marked than those of any of the cases reported thus far. Pulse had not risen; respirations, however, were thirty. On account of the restlessness of the patient it was impossible to have a temperature taken. Abdomen was distended and held absolutely rigid all through. Liver dulness was completely obliterated. A half-hour after the first complaint, pulse had risen sixteen beats. An hour after patient had begun to complain, the pain apparently abated and patient went to sleep. Patient vomited once before operation. As soon as consent could be gained, patient was taken to the operating room, three hours after pain was first complained of.

Operation.—Anæsthetic: ether. Time of operation: thirty minutes. Right rectus incision at the level of umbilicus. As the peritoneum was incised, a straw-colored fluid gushed out to the height of six or seven inches. Peritoneal cavity was found full of fluid with some solid particles of fecal material. Intestines were everywhere red and injected. Cæcum was located, ileum followed up, and a large perforation found about one foot above cæcum. This perforation was closed with difficulty, as it was situated in the centre of a large ulcerated area and the edges were very friable. Closure was done by purse-string suture of fine black silk, reinforced by several mattress sutures of the same material. This, it was found, had constricted to some extent the lumen of the gut; but the tip of one's finger could be passed through. Two cigarette drains with a rubber tube between them were laid through lower angle of incision to bottom of pelvis. One small strip of iodoform gauze was laid in the direction of the perforation. Closure with catgut.

Patient was put back to bed in the upright position and given continuous salt solution per rectum. Condition of patient after operation improved—pain, tenderness, and rigidity quickly disappearing. Temperature remained up, but pulse came down to same rate as before operation.

Liquid nourishment was started. Drainage from wound was profuse and drains were started early. On the sixth day after operation abdomen became very much distended; no movement of bowels could be induced; temperature jumped up to 106°, pulse to 180. Abdominal distention was so great that a loop of distended gut presented alongside of the drains in lower angle of incision. An intestinal obstruction was diagnosed (this having been feared at time of operation on account of encroachment of lumen of gut by closure of perforation) ; an opening was made with a cautery in the wall of the distended loop of gut presenting in wound, and the abdominal condition was promptly relieved.

Patient's general condition improved slowly for a few days, after which improvement was more rapid. There was, however, one other attack of obstruction on the thirty-fourth day after operation, which was relieved by enemata given through enterostomy wound, accompanied by vigorous abdominal massage. Aside from this the convalescence was uninterrupted, though somewhat delayed by the presence of a deep bed-sore occupying the sacral region. The temperature of patient had not reached normal until the forty-sixth day after operation. He was discharged on the sixty-third day with a small fecal fistula. Two weeks later the patient was seen, and by that time the fistula had closed entirely.

This patient was a brother of the little girl whose case was reported immediately before this (Case III). There were in the hospital at the same time four members of this family with typhoid fever. Two of them perforated, were operated upon, and recovered. A third was referred to above —a case of general peritonitis with no discoverable perforation. He was operated on at the same time as Case IV, and died the day following. The fourth member of the family had an uneventful attack of typhoid and recovered.

SPONTANEOUS RUPTURE OF THE SPLEEN IN THE COURSE OF TYPHOID FEVER.*

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THAT enlargement of the spleen to various degrees is constantly present in typhoid fever is well known clinically and emphasized by all text-books on internal medicine; but that the tension from within may be so great as spontaneously to overcome the thinned-out capsule and peritoneal investment is mentioned by comparatively few authors even as a possible complication of enteric fever. In looking over all available literature the writer finds that fourteen text-books on internal medicine do not mention spontaneous rupture of the spleen in the course of typhoid fever as even a possible complication. Four other text-books, however, state that it is possible and may occur.

Osler ("Practice of Medicine," 6th edition) says, "The spleen is invariably enlarged, rupture may occur spontaneously or as the result of injury. In the Münich autopsies, 2000 in number, there were 5 instances of rupture of the spleen, one of these was caused by abscess." A letter from Dr. Osler to the writer, December 6, 1908, says, "There was no rupture of the spleen in our Johns Hopkins Hospital series. . . . I have often wondered why the organ did not rupture, I have seen it like a bag of molasses."

Herrick [36] of Chicago says, "Spontaneous rupture of the spleen in typhoid fever seems to be extremely rare. No case has come under my notice nor do I remember to have heard of one in Chicago, where typhoid fever is not at all uncommon."

Stengel [14] states his experience as practically that of Herrick's.

Anders ("Practice of Medicine") says, "Kern has searched the literature and found only 9 cases of abscesses. In rare cases, either spontaneously or as the result of injury, the spleen may rupture; and the records of 2000 post-mortem typhoids at the Münich Pathologic Institute furnish 5 cases."

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* Read before the Tri-State Medical Society of Virginia and the two Carolinas, at its annual meeting in Charleston, S. C., February 17, 1909:

BUTLER ("Diagnostics of Internal Medicine") believes that "in the excessive degree of hyperæmia sometimes present in typhoid, malaria, and other fevers, spontaneous rupture may occur; traumatism is a more common cause."

The following series of reported cases of spontaneous rupture of the spleen in the course of typhoid fever have been collected * for the writer and are believed to be complete to the present time.

CASE I.—AASER[1] reports a case of rupture of the spleen following typhoid fever. Man, aged 20 years. Attack of typhoid fever running a two-weeks' course. Admitted to hospital and died one-half hour later. Autopsy, rupture of the spleen so great that a portion of the organ was almost severed from the rest.

CASE II.—COLLIN[2] reports a case of rupture of the spleen in enteric fever. Man, aged 19 years. Chronic diarrhœa, abscess of right lung, general peritonitis. Death. Autopsy. All the viscera mutually adherent, false membranes mixed with blood. Spleen ruptured in three places; two were superficial, but the other long and situated at the posterior border of the organ. There was a depression of 6 cm. Spleen weighed 225 grammes. The parenchyma was brownish-black in color.

CASE III.—CRAIG[3] reports a case of rupture of the spleen. A soldier, aged 23 years. Illness began eight days before admission to hospital. Diagnosed on transport as intermittent malarial fever. Admitted. Headache, diarrhœa, and tympanitic abdomen. Blood negative for malaria. Typical course of typhoid fever. Great pain in left hypochondrium. Collapse. Death. Autopsy. Coils of intestines mutually adherent, gas, purulent exudate, appendix inflamed greatly. Spleen had large laceration through the capsule, 3 cm. in length; the organ measured 20 by 11 cm. dark reddish-purple. Upper section showed dark mahogany red. Malpighian corpuscles indistinct, much congested; rupture went into the substance of the organ. Typhoid lesions in other organs.

CASE IV.—DARWIN[4] reports a case of rupture of the spleen in fever (kind not stated). Man, aged (?); soldier in Indian Infantry. High fever and great pain in abdomen. Diarrhœa, fæces pale yellow; abdomen somewhat hard and resistent (evidently typhoid). Death. Autopsy, seven hours after death. Green fluid escaped from the nose. Stomach distended, also intestines, coils adherent. Spleen adherent to abdominal walls, much enlarged. Capsule ruptured. Dark coagulating blood protruding.

CASE V.—ERICHSEN[5] reports a case of spontaneous rupture of the spleen in typhoid fever. Patient convalescent, when he suddenly fell backward and was dead. Autopsy. The spleen had a long rupture and

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* By Dr. Carl H. Von Klein of Chicago and his staff of foreign correspondents.

the wrinkled capsule surrounded a confluent, livid-red parenchyma, in which there was no trace of the normal tissue. The rupture was near the hilum and was from 3 to 4 inches in length. Liver much enlarged.

Case VI.—Lidell[6] reports a case of spontaneous rupture of the spleen in typhoid fever. Woman, aged 25 years. Admitted to hospital on Ward's Island (1849). "Ship fever." Had been ill three days. Usual symptoms of sudden internal hemorrhage. Death in one hour. Autopsy sixty-six hours after death. Peritoneal cavity contained 90 ounces of extravasated blood, 40 ounces of it firmly coagulated. Came from ruptured spleen. Peritoneal coat torn through. Splenic parenchyma soft and chocolate color. No injury and the rupture must have been spontaneous.

Case VII.—Nückel.[7] Man, aged 25 years. Fever with pain in the lower abdomen. Death. Autopsy forty-eight hours after death. Blood extravasation from the left hypochondrium to the entrance of the small pelvis. Was coagulated in large clots. Spleen ruptured in an angle-shaped tear. Spleen 5 by 4 inches. The surrounding fasciæ were so degenerated that they tore when touched.

Case VIII.—Peterson.[8] Man, aged 36 years. Soldier five days ill with typhoid fever. Great pain in lower abdomen. Death. Autopsy. Lungs œdematous, peritoneum injected. Spleen 17 by 8 by 4 cm. Yellow infarct size of hazelnut, convex surface ruptured.

Case IX.—Peterson.[8] Man, aged 21 years; attack of intermittent typhoid fever. Spleen region sensitive. Cyanosis. Death. Autopsy. Spleen much enlarged, particularly in longitude. Ruptured at both ends radiating to the capsule.

Case X.—Peterson.[8] Man, cigar-maker, great perspiration, attack of fever. Great pain in lower abdomen. Exudate in abdominal cavity. Death. Autopsy. Heart, liver, and kidneys showed parenchymatous degeneration; 1½ lbs. of pus in abdominal cavity. Spleen 16 by 11 by 5 cm. Ruptured on lateral end.

Case XI.—Peterson.[8] Man, aged 26 years; 17 days in hospital, typhoid fever. Vomiting, collapse, death. Autopsy. Heart lax and anæmic. Thick dark-brown blood in abdominal cavity. Peritoneum slightly injected. Intestinal walls suffused. Omentum thick. Spleen 19 by 13 by 3 cm., attached to the ventricular fundus. Rupture on lower lateral end.

Case XII.—Peterson.[8] Woman, aged 39 years; factory worker. Fever, delirium, vomiting, icterus, and death. Autopsy. Lungs œdematous and left pleura somewhat fibrinous. Spleen 16 by 11 by 6 cm., a row of infarcts seen through the capsule. Rupture of stomach portion.

Case XIII.—Peterson.[8] Boy, aged 11 years; factory worker. Intermittent typhoid. Death. Rupture of the spleen in part in the stomach.

Case XIV.—Peterson.[8] Man, aged 28 years; severe case of typhoid fever, death. Autopsy. Concretion of pus size of hen's egg in upper lobe of left lung. Heart degenerated. Spleen 19 by 14 by 5 cm., three ruptures on forward border with irregular broken edges.

Case XV.—Santi[9] reports a case of spontaneous rupture of the spleen in typhus. Patient, aged 20 years, complained of pain in the left hypochondriac region, particularly near the spleen. Left leg and foot swollen, owing no doubt to a venous thrombus. Typhus diarrhœa, condition serious. Entrance to hospital, fifty days later seemed to be improved. Temperature 38° C. Later felt violent pains in left side, involving the entire abdomen. Death in a few hours. Autopsy. Spleen much enlarged, jelly-like in substance; exudation of purulent matter into peritoneum. Recent discolorations. Two round ulcers in the abdomen; recent discoloration in the right kidney. Rupture of the splenic capsule no doubt due to recent and prior embolism.

CASE XVI.—SWAVING.[16] Spontaneous rupture of the spleen. Man, aged 35 years, Chinese; malignant typhoid. Enlarged spleen and liver. Ran a course of four days. Death. Autopsy. Thin, serous, bloody fluid in the abdominal cavity. Large black lump of blood covered entire spleen and part of the stomach. Liver hypertrophied. Spleen 20 by 10 by 7, weight 6 lbs. Diagnosed rupture, 2 inches in length and 1 inch deep. Pulp in the tear, a red-brown mass, vessels empty. Spleen solid substance. All the other organs (except liver and spleen) were empty of blood.

CASE XVII.—HEIMANN[10] reports a case in which the extension of the spleen was so remarkable that the organ ruptured and the jelly-like substance emptied into the abdominal cavity. It was full of whitish-yellow spots.

CASE XVIII.—WITTMANN[17] reports a case of rupture of the spleen in typhoid fever. Boy, aged 10 years, healthy, well-built child. Attack of typhoid fever. Skin hot and dry. Rapid respiration and cough. Strong pulse, 120. The splenic dulness began on the lower border of the eighth rib and lapped the last false rib. Patient somnolent and half delirious, great thirst. Death. Postmortem. The stomach contained great quantity of "coffee-colored" fluid. Liver pale and gall-bladder almost empty. Spleen much enlarged; 2½ inch rupture, beginning at the spleen entrance and ending on the upper surface.

CASE XIX.—GRIESINGER[11] describes a case of rupture of the spleen in typhoid fever. Patient in delirium jumped out of the window. Death twenty-four hours later. Autopsy revealed, in addition to other injuries, a rupture of the spleen in three different places. There was a slight extravasation of blood.

CASE XX.—WEST and DUDDING[18] report a very rare case of typhoid fever complicated with spontaneous rupture of the spleen. Man, soldier, aged (?). Headache of two days. Abdomen slightly full, but not marked enlargement of spleen. Temperature rose above 103°, a few rose spots on abdomen on third day. Abdominal pain, pulse weak and rapid. Perforation suspected. Operation. Blood in lower abdomen and intestines floated upward, collapse and wound closed. Death. Necropsy. Spleen enlarged and ruptured three inches on diaphragmatic surface. Weighed 2 lbs. and 2½ ounces, capsule separated by clot. Duration of disease eight days.

CASE XXI.—CHROSTOWKI.[13] Patient, blacksmith, aged 27 years, who was sick for several days before a physician was consulted. He was delirious and when the physician arrived he found the temperature 40.3° C., pulse over 100, respiration 24 to the minute. On the second day the patient became very delirious, desperately attempting to get out of bed. The slightest touch on the left side in the region of the spleen seemed to him the pangs of death; often signing and pointing to the region of the spleen. Temperature 39.4° C., pulse 126, respiration 40, nose and ears cold and cyanotic. The abdomen was enormously enlarged. Ice compresses were applied over the abdomen, he became thoroughly unconscious about 3 o'clock the next morning and died at 7 o'clock the same day. Postmortem revealed the spleen to be six times the usual size, the outside being covered with thick dark blood; and when the blood was removed it revealed a vertical rupture of the spleen from 8 to 10 cm. long. The splenic artery was also torn.

Case XXII.—Chrostowki.[12] Patient, 18 years old, typhoid fever; was six days in bed before going to the hospital. Temperature 40.5° C., respiration 24. He continued in the same condition up to the tenth day at the hospital, which was considered good, notwithstanding that he lost a great deal of strength. About the sixteenth day in the hospital he became delirious, the temperature being 38° C. in the morning to 40.4° C., pulse 126. Next day the temperature fell to 37.6° C., pulse 100, respiration 28. Patient seemed to feel better, but on the eighteenth day he died at 6 o'clock. Postmortem revealed a rupture of the spleen 3 cm. long. The spleen was found considerably enlarged, was surrounded with thick coagulated blood, and the splenic artery torn. The spleen was removed, and upon examination internally it was found that the pulp of the spleen was also ruptured and filled with thick coagulated blood.

Case XXIII.—Delafield.[19] Typhoid fever, rupture of spleen. Boy, 8 years old; two weeks ago caught cold; seized with cough, fever, coffee-ground sputa, a little pain in the right side of the chest. Worse every afternoon. No diarrhœa or epistaxis. Tongue clean; pulse 100, temperature 99¾°; bowels regular; urine 1010, no albumin. Coarse râles over both lungs.

October 29, pulse 100–112, temperature 99¾°–102¼°.
October 30, pulse 114–122, temperature 100° –103½°.
October 31, pulse 104, temperature 100¼°.
November 1, pulse 96–120, temperature 99° – 98½.
November 2, pulse 98–120, temperature 99° – 98½°.
November 3, has been improving, to-day sat up.
November 7, complains of weakness, stays in bed.
November 10, suddenly much worse.
2 P.M., pulse 145, temperature 104¼°.
8 P.M., pulse 144, temperature 105½°.

November 11, 2.30 A.M., was found in the hall dying. Died 3 A.M.

Autopsy, November 11, 2.30 P.M.—Brain, slight increase of serum beneath; heart, normal, not softened; lungs, moderate bronchitis; liver, normal.

Spleen, 14 ounces, a very large rupture extending all around it at its middle. In the peritoneal cavity a large amount of blood. Large intestine normal. Along entire length of ileum, solitary and agminated glands very much swollen and a very few of them ulcerated. Small nodules in mucous membrane. Mesenteric glands very much swollen.

Case XXIV.—Afanassjeff[13] relates a case of rupture of the spleen in typhoid fever. Patient a medical student, aged 24, weighing 148½ pounds. Diagnosed at first some form of intermittent fever. He complained of great deal of pain in left side with a temperature of 40° C. The high temperature indicated a case of infection and was pronounced typhoid fever. The patient constantly complained of severe pain on the left side and of being unable to lie on that side. The spleen could be felt to enlarge daily. Quinine was administered for twenty-three days, when it was noticed that the enlargement of the spleen extended below the ribs more than three inches wide, very painful to the touch, showing that suppuration had taken place. Dr. Pineck, the consulting physician, introduced in several places an exploring needle, between the lower ribs in the axillary line, but no pus was obtainable. He later for the second time introduced an exploring needle with some success in bringing pus, which was passed under the microscope and found to contain suppurative matter. An incision was made below the lower rib in the axillary line of the extended part, bringing forth a large volume of pus mixed with blood. A digital examination was made, the finger found its way to rupture of the spleen. The spleen was treated accordingly, and owing to the vitality of the patient he recovered.

To these I now add another case, as follows:

Case XXV.—Bryan. Mr. L. M. S., aged 31, married, blacksmith, Dry Creek, W. Va., having always enjoyed good health, Saturday, October 31, 1908, came home from work, stating that he had felt badly all the week. Dr. O. F. Richter was called in, temperature at 3 P.M. was $103^4/_5$°, patient complained of headache and nose bleed. Sunday, November 1, temperature at 11 A.M. was $103^3/_5$°; hospital recommended. Monday, November 2, temperature at 6 A.M., $103^1/_5$°; patient sent to the Virginia Hospital, Richmond, Va., 200 miles distant.

November 2, 5 P.M. on admission, a well-developed muscular man, height 5 ft. 10 in., weight 175. For a week past has had fever; complains now of slight headache and a moderate pain in the left side under the ribs. No significance was attached to this pain at the time, it being supposed to be muscular or from some strain in transportation. The tongue was coated and furred, cheeks flushed, abdomen moderately distended and tympanitic, the spleen not felt, some few rose spots.

The course of the patient's temperature, although very high during the succeeding two weeks, responded readily to the alcohol rub. In lucid intervals, at times he complained of an indefinite pain in the abdomen, while at other times it was referred to the left thigh and knee. When questioned more closely the true location and severity could not be determined. He was constantly under the attendance of a day and night nurse. The alcohol rubs were given on woollen blankets upon which he was gently rolled, every four hours, the temperature exceeding 103° F. The diazo reaction was positive on each examination. The patient was never violent nor out of bed, nor assumed the sitting posture. No physical examination was made of the spleen other than daily inspection and superficial palpations of the abdomen. The nourishment was liquid. The bowels moved daily. The temperature was taken by rectum except when otherwise stated.

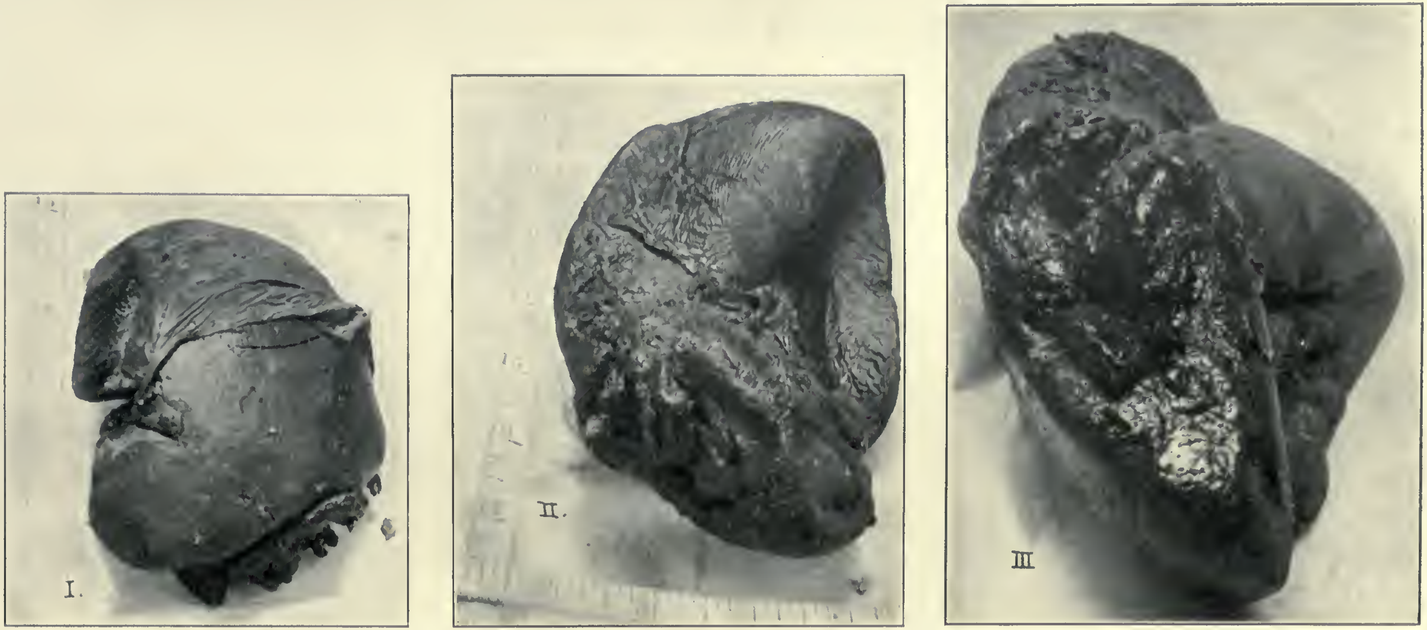
SUNDAY, NOVEMBER 14.

	Temperature.	Pulse.	Respiration.
4 A.M.	$104\frac{2}{5}^\circ$	116	22
Rectal (after alcohol rub)	$103\frac{1}{5}^\circ$	88	20
8 A.M.	$104\frac{1}{5}^\circ$	96	26
Rectal (after alcohol rub)	$102\frac{3}{5}^\circ$	92	20
12	$104\frac{3}{5}^\circ$	96	28
Rectal (after alcohol rub)	$104\frac{1}{5}^\circ$	92	28
4 P.M.	105°	110	30
Rectal (after alcohol rub)	$104\frac{1}{5}^\circ$	92	28
8 P.M.	$105\frac{4}{5}^\circ$	136	28
Rectal (after alcohol rub)	$104\frac{4}{5}^\circ$	130	30

The writer was called and at 8.30 P.M. found the temperature, by axilla, 106°, pulse 138, respiration 36.

The face was pinched, nose and extremities cold, moderate dyspnœa. The pulse was rapid, weak, running, but regular. The belly hard, resistant, and tympanitic, but not distended; knees extended. There was no absence of the liver dulness. Diagnosis: Perforation and hemorrhage.

The hyperpyrexia could not be accounted for. The patient was carried immediately to the operating room; and under ethylchloride and ether narcosis, which was intermittently administered, an incision 15 cm. in length along the outer border of the right rectus muscle was made. The intestines were turned out on hot pads and a systematic search made for the perforation. None was found. Moderately thickened Peyer's patches were evident here and there. Enlargement of some mesenteric glands



Ruptured spleen, size 7 x 3⅞ inches. Site of rupture, inferior pole. I. Anterior view. II. Inner view. III. End view.

was noticed. During the progress of evisceration quantities of blood would now and then well up into the wound. A gauze sponge carried down to the pelvis was saturated with blood and a few clots. The incision was now extended further down, and the pelvis found to be filled with about 10 to 15 ounces of dark tarry blood with few coagula. This was removed but rapidly reaccumulated. Infusion into the left median basilic ordered, 30 ounces normal saline.

The peritoneum was normal. There was considerable ballooning of the sigmoid. The iliac veins were supposed to be the source of hemorrhage, but were found normal. The spleen being suggested as the possible source of the hemorrhage the operator ran his hand upward, to feel a soft, pulpy, enlarged, and movable tumor, from about which large quantities of blood, blood-clots, and splenic pulp were raked away. The incision was now rapidly carried upward and toward the middle line within a few cm. of the xiphoid cartilage. The spleen was turned out on the belly wall; there were no adhesions; its pedicle was clamped, transfixed and cut, and the organ removed.

Infusion of normal saline again ordered, patient taking up about 50 ounces. Blood clots, coagula, and splenic pulp were wiped away; the peritoneal cavity filled with a quart of hot saline solution; the wound rapidly brought together by through-and-through sutures of silkworm gut. Despite succeeding measures to combat the shock and loss of blood, the patient died in one hour. No autopsy was allowed. The spleen measured 18 by 9 cm. and weighed $14^2/_3$ ounces.

The rupture was at the lower pole, stellate, everted, crater-like, from which small masses of splenic pulp were dangling. The organ was soft, pliable, pulpy, of a dark blue to blackish color. The capsule had been torn across at the site of the rupture and had retracted upward anteriorly and posteriorly as high as the hilum. The normal contour and shape of the spleen were evident. It is impossible to say, in the haste of the operation, how much blood was found in the abdominal cavity, probably one quart or more.

The writer is indebted to Dr. E. G. Hopkins, pathologist of the Virginia Hospital, for the following pathological findings:

" The tear extends 16 mm. into the substance of the organ and occupies an area of 22 by 38 mm. on the surface.

"The tissue surrounding this lesion is markedly hyperæmic and presents numerous areas of extravasated blood. Considerable areas consisting of large pale, partially necrotic cells are abundant in the splenic pulp, the Malpighian bodies being practically normal. A mural thrombus was found in one of the veins. Groups of bacilli are present in the blood-vessels and scattered throughout the sections."

The following cases recorded as spontaneous ruptures of the spleen by their respective authors should also be reported. It seems most improbable, however, that a ruptured spleen in the course of typhoid would go on to recovery without operative intervention.

CASE XXVI.—KERNIG[20] reports a case of spontaneous rupture of the spleen in typhus. Man, aged (?); healthy, strong. Attack of typhus exanthematicus. Fourteen days of convalescence and then four (not lasting) feverish attacks. At each slight attack the spleen increased in size; after the last one the organ was much enlarged. Vomiting and pain low in the epigastrium; collapse; and death feared. Abdomen distended. From the arch of the ribs to the os pubis was a large swelling. No sensitiveness on pressure. Disappearance after thirteen days. Beginning of pneumonia and then recovery. Diagnosis: rupture of the spleen, possibly through an infarct.

CASE XXVII.—STEUDEL[21] reports a case of rupture (?) of the spleen in typhus fever. Man, aged 28 years. Officer, returned from East Africa. Had had malarial fever and on return had attack of typhus fever. A spleen tumor was suspected but could not be symptomically defined. Recovery. Probably a rupture of the spleen or diaphragm. In this case (a strong young man) a rupture of the diaphragm was the least likely, so undoubtedly the rupture was of the spleen.

CASE XXVIII.—HARTLE[22] reports a case of rupture of the spleen in typhus fever. Boy, aged 13 years. Attack of intermittent typhoid fever. Spleen abnormally swollen so that the border overlapped the umbilicus. It felt like an enormous bladder filled with water. Destroyed the functions of the chylopoietic viscera. Convulsions; pulse could not be felt. Abdomen had been soft and lax, but was now much distended. Spleen probably ruptured and contents escaped into abdominal cavity. Recovery.

The one instance of splenectomy reported during the course of typhoid fever is that of (Ashby[23]) Case XXIX. A case of wandering spleen in typhoid fever. Patient woman aged 22 years. Large mass in left inguinal region. Temperature

104°; pus tumor suspected. Laparotomy. Enlarged spleen wedged in pelvis. Pedicle, 8 inches long, was ligated and spleen removed. Other organs normal. Typical typhoid course. Was a malarial spleen, contracted in a malarial section of the country. Recovery.

In this instance despite the high temperature and typhoid condition an enlarged, unruptured, wandering, malarial spleen was successfully removed. A letter from Dr. Ashby to the writer, January 9, 1909, says, " The temperature chart showed a most erratic course, as her temperature would jump from 98½° to 106° and rise and fall in the most eccentric manner. The patient had atypical typhoid fever, which did not show up until after her spleen was removed. The spleen was impacted in her pelvis. She made a perfect recovery and five years after the operation she was in perfect health, had married, given birth to a child, and had gained 20 pounds in weight. I regret that I cannot give you further data."

Carstens [37] reports 122 ruptures of the spleen from hypertrophy or injury, with 83 recoveries and 39 deaths.

Rupture of the spleen in the course of malarial fever is not uncommon; many cases have been reported. It is not the writer's intention to take up the many other causes of rupture of the spleen in parturition,[35] trauma, ecchinococcus, cystic degeneration, varices,[38] hypertrophy, following epistaxis,[39] abscesses,[24] malignant overgrowths, infarct, torsion; but suffice it to say that the removal of this organ (Carstens [37]) has been accomplished 739 times to January 1, 1905, with 521 recoveries and 197 deaths. Since then there have been many splenectomies performed and the operation for leucocythemic hypertrophy with its large death rate having been abandoned, the total mortality for splenectomy, 26 per cent., would be considerably lowered.

Anatomical Location of Spleen.—The normal area of spleen dulness is ovoidal in shape, its long axis corresponding to the direction of the ribs; and is found between the lower border of the eighth rib and the eleventh intercostal space, between the mid-scapular perpendicular posteriorly and the midaxillary perpendicular anteriorly. The normal spleen is palpated with great difficulty, if at all, by virtue of its covered position under the costal arch.

Etiology.—Adler [25] says regarding spontaneous rupture of the spleen in typhoid fever, that it has been demonstrated that the Eberth bacillus is found most often with the exception of the intestinal tumors and in the swollen mesentery glands) in the spleen. Numerous experiments and observations, therefore, have been made with culture of the juices of the ruptured spleen to decide a difficult case of diagnosis of abdominal typhus; and certainly the most solid proof we have of this "splenic toxæmia" is the great danger to life when the spleen ruptures.

Philipowicz [26] made examinations in four cases of abdominal typhus to discover the bacillus in the spleen. The spleen was punctured with the Pravaz syringe and the juice subjected to bacteriological investigation. Typhus colonies were found in great numbers. He concluded that this is the surest method for positive diagnosis.

In the laboratory Newhauss [27] performed experiments on rabbits and mice with the juice obtained by means of a Pravaz syringe from the enlarged spleen in the course of severe typhoid, his results being identical with Koch-Eberth bacillus of typhus abdominalis.

Laveran,[28] too, reports a case of typhoid with an examination for bacillus at the autopsy. Bacteriological examination of the splenic pulp grown in gelatin gave a perfect culture of Eberth's bacillus.

Hein also demonstrated this bacillus taken from the spleen.

Pathology.—Malinin [29] says that the spleen lacks the fibrous tissue to give it a structural foundation as well as certain lymphoid or round-shaped elements. All the firmness or consistency it possesses is in the characteristic spindle-shaped splenic cells: these are capable of extraordinary contraction and are attached to the neighboring cells; this gives the spleen construction. The strong permanent kernels of the splenic tissue have a lively amæboid movement, and form a cavity in which all the dead cells, red and white, are taken out of the circulation. These degenerate and get into the circulation as white blood-corpuscles. The spleen cells form rapidly. In intermittent fever multitudes of the blood-cells are ruined and the splenic cell-kernels take up the ruins. This obtains in typhus (abdominalis).

Lidell,[6] concerning his case of spontaneous rupture of the spleen in typhoid fever, says that the causes of the rupture seem to be several: (1) Softening of all the structures of the organ, including coats of the blood-vessels. (2) Intense congestion of the portal vein and radicles; this often comes with the early stages of petechial typhus and malarial fevers. (3) Stagnating blood distending and pressing the soft walls of the blood-vessels in splenic surface; this forces blood between splenic tissue and capsule and invested peritoneum. (4) Blood increasing compresses the parenchyma on one side and dilates the capsule and peritoneum on the other. Possibly the spleen may have been previously weakened in some unknown manner.

Heimann [10] reports an epidemic of typhus in the Military Hospital, beginning in April, 1840. The numerous deaths gave opportunity to study the changes in the spleen. In many cases it was found to be enormously distended, sometimes more than three times the natural size; then the lower end reached the border of the pelvis; the substance was much attenuated and weakened.

Zimmermann [32] believes that in cases of typhus the swelling of the spleen never fails and there is a predisposition to rupture. Spontaneous rupture is rare, but the organ is ready to be ruptured by blow or fall or sudden movement of the body. It is a question whether all so-called "spontaneous" ruptures are not in this class. The period in which the organ reaches its greatest magnitude varies greatly, from the end of the first week to eighteen days.

Mosler [15] says that where there are pathological changes in the spleen a rupture may occur spontaneously, or may be brought about by traumatic influence. Spontaneous ruptures are the consequences of an acute and very rapid swelling or extension of the organ. Rokitansky thinks it comes oftenest in typhoid fever and in intermittent fevers. In the latter cases it occurs in the period of the chill. Death usually follows in twenty-four hours.

Cantlie[30] explains spontaneous rupture of the spleen in pernicious or intermittent fever by the softening of the tissue and the adhesion of the organ to its visceral neighbors, the weakness and immobility predisposing to rupture.

Boinet[31] attributes spontaneous rupture to the same cause.

Wilson[33] thinks it most probably that in the so-called "spontaneous rupture" the exciting cause is an action of muscular pressure while the subject is turning or moving suddenly. He does not believe that the spleen ever ruptures without this impetus, however softened and coagulated it may be.

The size to which the spleen may enlarge is not so dependent upon the degree of intoxication as upon the resistant force of its enveloping capsule, and of its properitoneal and peritoneal investments. The restraining influence of this extraperitoneal connective tissue can be but little; the cross leaves of its fibres are readily stretched and separated; the organ crowds through the separation and is now held back by the peritoneal coat alone, which eventually, being unable to withstand the increased tension, gives way and decides the physiologic instant of spontaneous rupture.

FINDINGS BY AUTOPSY OF RUPTURED SPLEEN IN TYPHOID FEVER.

Weight of spleen...	Largest, 6 lbs., Case XVI. Smallest, 225 Gr., Case III.
Size of spleen......	Largest, 20 by 10 by 7 cm., Case XVI. Smallest, 5 by 4 inches, Case VII.
Length of rupture..	Longest, organ almost severed, Case I. Shortest, 3 cm., Case III.
Number of ruptures	Three in Cases II, XIV, XIX. Two in Case IX. One in 20 Cases.
Depth of rupture...	Greatest, 6 cm., in Case II. Least, 2.5 cm., in Case XVI.
Shape of rupture...	Angle-shaped in Case VII. Irregular edges in Case XIV. Crater-like in Case XXV. Not mentioned in remaining cases.

Site of rupture	At or near the middle in Cases II, V, VIII, XII, XIV, XVIII, XX, XXI, XXIII. At or near the ends in Cases IX, X, XI, XXV. Not mentioned in remaining cases.
Rupture into neighboring organs	Stomach, Case XIII.
Amount of blood in peritoneal cavity	Greatest mentioned, 90 ounces, Case VI. Least mentioned, 1 quart, Case XXV.
Condition of spleen	Not mentioned in Cases I, VII, VIII, IX, X, XI, XII, XIII, XIV, XVIII, XIX, XX, XXI, XXII, XXIII. In remaining cases described as: Brownish-black, bluish-black, purplish; mahogany, chocolate, etc., etc.; pulpy, soft, pliable, etc.
Condition of splenic vessels	Splenic artery torn, Cases XXI, XXII.

Peterson [8] thinks that the median and convex part of the spleen are most exposed to danger of rupture of the capsule. It is here that the support is greater but the channels larger.

In three out of five cases reported by Cantlie [30] the rupture was near the hilum in the shape of a star, and in other cases of Cantlie's noted in Hong Kong the rupture was in each instance behind the hilum longitudinally and as if cut with a sharp knife.

Vigla [34] states that the form of rupture is linear or round and the quantity of extravasated blood usually very great.

Fatal termination seems to be the only outcome for rupture of the spleen, regardless of its size or depth, for if hemorrhage does not exsanguinate the poison overwhelms.

SYMPTOMS.—Vigla [34] says the usual symptoms are a pain in the splenic region, distention of the abdomen, and very often vomiting, small pulse, unconsciousness, with constitutional energy to the last. Death is the outcome.

The symptoms should be divided into (1) a preruptured period and (2) the postruptured period.

1. *Preruptured Period.*—Earlier in the disease the patient complains of the pain attendant upon the stretching of the capsule and investments, which is intermittent, not constant, of short duration, and lancinating. The tumor fills to various

degrees the left flank, its edge is not sharp but rounded, and feels soft or boggy. Blood-count is insignificant. The tumor is differentiated easily from the kidney. Later the hebetude, lethargy, and typhoid state, dependent upon the degree of intoxication and not upon the size of the spleen, are sufficiently overwhelming to allow no subjective signs. Intestinal disorders and tympany should follow from the splenic colon becoming angulated. What we bear constantly in mind is a large flabby tumor with an always weakening and thinning belt.

2. *Postruptured Period.*—This may be summed up in two words: (*a*) hemorrhage; (*b*) sepsis. The loss of blood is immediate and great. The tumor, if formerly much enlarged, is now smaller, irregular in outline, or may not be felt at all; the pulse is rapid, thready, and weak; the facies pinched and cold. There is air-hunger and restlessness. The delicate, highly organized, and multiple lymphatic channels in the rapidly-absorbing peritoneal roof and walls of the abdominal room are overwhelmed by the escaping poison from the spleen; and the temperature is high, 104°–107° F.; the patient complains of slight or no pain, the belly wall is hard and tympanitic, or flat in the flanks. There is no loss of liver dulness. Rectal examination is negative. The physiological moment of rupture is instantaneously signalized by shock, profound and progressing; and following rapidly, contrary to established rules in other surgical conditions of shock, there is a hyperpyrexia which so crushes the vital energy and remaining sparks of life that the treatment can be only surgical, immediate and radical.

The Treatment.—The patient should not be moved from the bed; an incision along the outer border of the left rectus allows easy access; clamping, tieing, and removal is a matter of only a short time. Large coagula, splenic pulp, and clots must be raked out of the pelvis and the hand run up under the diaphragm to remove any accumulation there. Infusion, auto-infusion, saline enema, the peritoneal cavity filled with normal salt solution, heart stimulants, and a moderate Fowler's position with oxygen are the surgical procedures which should be tried as indicated.

A review of the foregoing shows twenty-eight reported cases of spontaneous rupture of the spleen in the course of typhoid fever, which with the unreported Münich cases, five in number, and Cantlie's five, make a sum total of thirty-eight cases. The condition was undiagnosed in every instance. In one (Case XXIV) aspiration of the splenic abscess was carried out successfully. In Case XX operation was performed for perforation, none was found; lineal rupture, the condition being unrecognized; the procedure abandoned, death. Case XXV, operation performed for perforation; ruptured spleen found and removed; death. In Case XXIX Ashby removed an enlarged unruptured malarial spleen in the course of typhoid fever. Recovery.

CONCLUSIONS.

1. That enlargement of the spleen to some degree is constantly associated with typhoid fever.
2. That splenic rupture in the course of typhoid fever occurs more frequently than is clinically recognized.
3. That many cases of lineal rupture have gone to death undiagnosed.
4. That many such cases have been diagnosed perforation and because of medical prejudice have been denied surgical help.
5. That it occurs most frequently in the beginning of the third week, and then during the actual stage of convalescence. This latter is probably explained by muscular effort.
6. That any reference to pain on the part of the patient under the left costal arch should put the attendant on his guard.
7. That the normal spleen cannot be palpated satisfactorily.
8. That the spleen does not have to assume great dimensions for spontaneous rupture (Case VII).
9. That the enlarged typhoid spleen should never be handled, but should be touched daily.

10. That marks upon the skin with the date at the end of the line would indicate the increase in size.

11. That in all cases of typhoid an ice-bag should be constantly applied to the spleen.

12. That in cases of enlarged spleen the patient should be bathed most gently and carefully.

13. That a sudden increase in the pulse-rate, 20 or 30 beats, at any time during the course of this disease, should be investigated thoroughly.

14. That if this increased pulse-rate is attended by evidence of shock (hemorrhage), the attendant should be notified instantly.

15. That if the liver dulness is not obscured, and a rapidly rising temperature soon sets in, rupture of the spleen is the tentative diagnosis.

16. That pain is an insignificant diagnostic sign of rupture.

17. That on diagnosis, infusion, and Fowler's position should be instituted immediately before operating.

18. That the use of adrenalin, ergot, and iron preparations would seem to be of little value.

19. That the only hope for recovery is in operation.

20. That in the course of operation for intestinal perforation the spleen should be gently palpated through the abdominal incision and, if like a bag of molasses, should be removed.

21. That all the grave complications of typhoid fever are essentially surgical.

22. That a typhoid state is no contra-indication for operation (Case XXIX).

23. That aspiration of the pus tumor can be carried out (Case XXIV).

24. That continuous peritoneal lavage with normal salt solution by means of two glass tubes, the giving one in the upper end of the incision (subdiaphragmatic) and the receiving tube a suprapubic stab, should be employed after removal of the organ.

25. That Roentgenography may be employed in suspected cases.

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ILEOCOLIC INTUSSUSCEPTION IN AN ADULT.

WITH REMARKS ON THE METHOD OF FORMATION AND GROWTH OF THIS VARIETY OF INTUSSUSCEPTION.

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Ileocolic intussusceptions have hitherto been placed in a separate class from all other varieties on account of the different manner in which their growth is supposed to take place. It is commonly taught that it occurs as the result of prolapse of the ileum through the ileocæcal valve, that increase in length takes place entirely at the expense of the entering layer, and that consequently its apex is continually changing; this is an entirely opposite mode of growth to that which takes place in other varieties of intussusception.

To quote from a recent account written by the late Harold Barnard[1]: "In simple ileocolic intussusception the ileocæcal valve remains fixed whilst more and more ileum is prolapsed through its orifice into the cæcum." This is the generally accepted method of growth, of the curious nature of which no satisfactory explanation is forthcoming.

The following case illustrates what I believe to be the correct method of formation of ileocolic intussusceptions, bringing them into line with all other forms.

Woolf K., aged 30, was admitted into the London Hospital under my care on February 25, 1909. While at his work as a paperhanger, twenty-four hours before admission, he was suddenly seized with cramp in the lower abdomen. He vomited within a few minutes of the onset of the pain, and vomiting continued at frequent intervals. Two hours after the commencement of the illness he passed two loose stools, which, when cross-examined after his recovery, he stated were "red." Except for this, there was absolute constipation. The pain after the onset continued to be paroxysmal and cramping. He gave no history before operation of the passage of blood and no mucus was passed. He looked ill, his face was pale, his eyes sunken, and he was groaning with pain. There was no doubt from his appearance that he was suffering from a severe abdominal lesion.

The abdominal wall moved fairly well, but there was slight rigidity in the right iliac region and an indefinite lump was present here. On examination per rectum, the rectovesical pouch appeared to be filled with fluid.

FIG. 1.

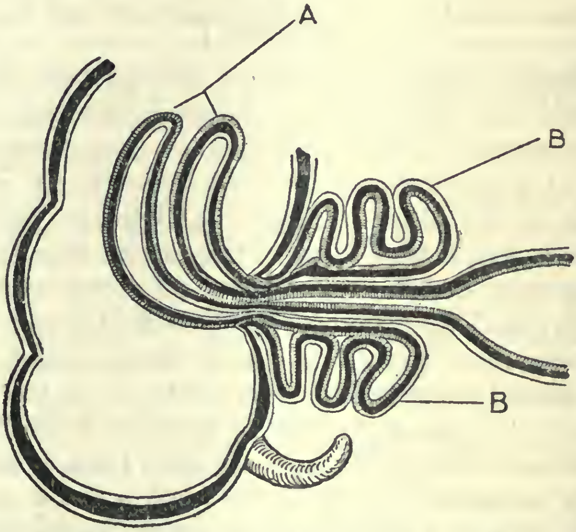

Diagram illustrates the condition found at operation. *A*, intussusceptum projecting into the cæcum through the ileocæcal valve. *B.B*, folded sheath of enteric intussusceptum.

It was obvious that he was suffering from acute intestinal obstruction, but I was unable to suggest its cause. I operated at once.

On opening the abdomen a considerable quantity of fluid escaped. Exploration revealed a mass in the ileocæcal region, evidently an intussusception. On bringing it outside I felt an elongated tumor in the cæcum. The ileum immediately internal to the cæcum was thrown into loose folds but the cæcal wall was not invaginated (*vide* Fig. 1). The condition was evidently an enteric intussusception in the process of passing through the ileocæcal valve. After squeezing its intussusceptum out through the ileocæcal valve, an ordinary enteric intussusception was left; this had started about a foot from the ileocæcal valve. I reduced it with considerable difficulty, and could find no cause for its commencement.

The patient made an uninterrupted recovery and left the hospital March 18.

But in addition to this mode of formation of an ileocolic intussusception as the result of the growth of an enteric, the condition may be primary and consist of the prolapse of part of the circumference of the ileum through the ileocæcal valve; but even in these cases no increase in size takes place at the expense of the entering layer, the ileocæcal valve, grasping the prolapsed ileum, passes on into the colon, forming a double intussusception. Special attention has been directed to the frequency of this form of intussusception by Corner[2] who named it "ileocolic-colic." In other cases the whole of the circumference of the ileum may be involved as the result of the unfolding of a small enteric intussusception just above the valve (Corner). In this form again no increase in size takes place, but it becomes an ileocolic-colic intussusception by involvement of the colon.

It is now over thirty years since Leichtenstern[3] described under the name "iliaca ileo colica" the variety of intussusception just recorded. He wrote of it thus: "A primary ileum invagination in the lower part of the ileum, which by its increase has passed its intussusceptum through the cæcal opening into the colon * * * * it cannot then be determined whether the invagination was primary ileocolic or iliaca ileo colica."

This does not seem to have received the notice it deserved, at any rate it has not obtained admission into the general surgical text-books in use in this country. It is mentioned in Sir Frederick Treves' monograph[4] and by Harold Barnard[5]; but these writers do not appear to have pointed out its bearing on the formation of ileocolic intussusception. Attention has recently been directed to this point by Fitzwilliams,[6] who, however, makes no mention of Leichtenstern's recognition of its occurrence.

The nomenclature of intussusception is still in a somewhat unsettled state. Undoubtedly the simplest and the best classification is that proposed by Cuthbert Wallace,[7] which I have already advocated.[8] The term ileocæcal is confined to the variety of intussusception in which the apex of the intussusception is formed by the ileocæcal valve, and is dropped as the name of a class, the term enterocolic being employed.

The three groups are therefore: (1) enteric; (2) colic; (3) enterocolic.

The last named group, in which both small and large intestine are involved, is the most common, and contains many varieties of intussusception; the name ileocolic should be retained for one of these, remembering that it is a stage either in the growth of an enteric intussusception or in the evolution of an ileocolic-colic.

True ileocolic intussusceptions are uncommon. Out of 717 cases collected by Fitzwilliams[9] 67 were said to have been ileocolic. In the 45 cases upon which I have operated only 2 were ileocolic. The intussusception which starts as a small prolapse of the ileum into the colon and increases as a colic intussusception (ileocolic-colic) has been in my experience one of the most common forms of this disease.

To recapitulate: A complete ileocolic intussusception starts as the enteric variety. On reaching the ileocæcal valve the intussusceptum passes through, its apex as in other forms remaining unchanged. Further growth results in the colon participating, no fresh ileum is involved. When an ileocolic intussusception has been formed, whether as a small prolapse or as the result of the infolding of an enteric invagination, it does not increase in size by more ileum becoming prolapsed, but by the intussusception passing onwards in the colon and becoming ileocolic-colic.

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A VERY EARLY FORM OF RENAL TUBERCULOSIS REVEALED BY NEPHRECTOMY.*

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The routine of cystoscopic examination and ureter catheterization has in turn led to the prompt recognition of tuberculosis of the kidney, and hence the *pium desiderium* for an early recognition of this condition. The force of this teaching has gathered strength in its onward march, and yet it is a common experience to find that what passes for an early recognition of the lesion clinically can hardly be considered such in the light of the extensive pathological changes in the kidney, found *in situ* at operation, and still more clearly upon its removal.

The case herewith reported shows that the reverse may exist, a full appreciation of which fact and the lesson to be learned therefrom will be best gathered from the history and sequence of events in the course of operation.

Case.—The patient, M. S., No. 100,143, aged 41, was admitted to Mt. Sinai Hospital May 26, 1908, He claims that after an attack of gonorrhœa, five years ago, a frequency of urination persisted with pain and that he felt as if he never completely emptied his bladder. Ten months ago, for a presumed stricture of the neck of the bladder as explanatory of his condition, he submitted to an operation of perineal section and galvanocaustic division of the stricture (?). No relief followed the operation. Thereafter he states the frequency of urination at night occurred at half-hour intervals.

Examination.—The urine was smoky and interspersed with particles of blood-stained tissue. Microscopic examination showed the presence of leucocytes and some few tubercle bacilli, the urine reacting acid. External genitals were normal in size and not hypersensitive. The prostate was moderately enlarged and tender. The capacity of the bladder was short of 125 c.c., and the introduction of the catheter and cystoscope alike painful.

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* Read before the American Urological Association, June 8, 1909.

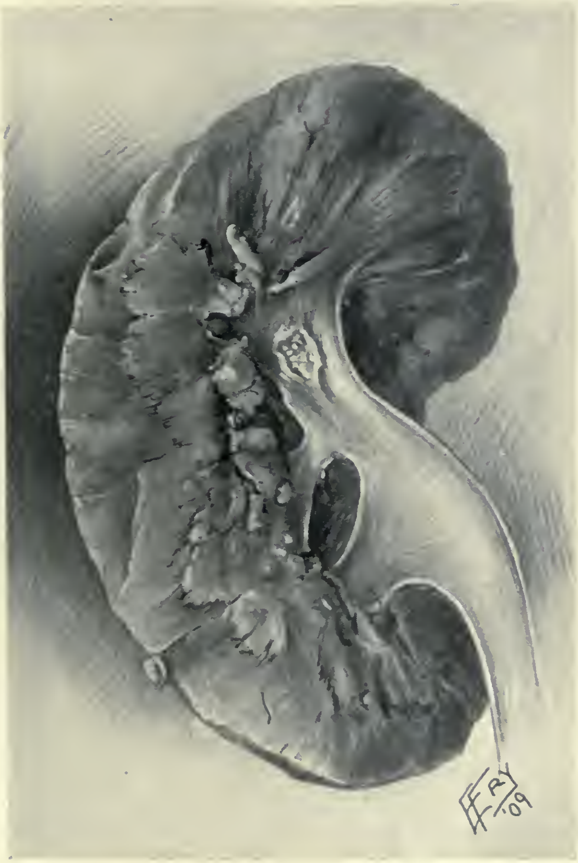
Cystoscopy (Nitze cystoscope).—Right ureter, normal slit with a slight submucous hemorrhage. The left half of the trigone markedly different. The left ureter golf-holed and an ulcer in its vicinity and the surrounding mucosa injected.

Chromocystoscopy.—Following the intramuscular injection of 4 c.c. of a 4 per cent. solution of indigo carmine, the urine, stained faintly blue, issued from the right ureter after eight minutes, but none escaped from the left ureter after an observation of twenty minutes.

Ureteral Catheterization.—The right ureter could be easily entered and the urine obtained was slightly blood-stained, acid, and contained no pus and no organisms. Urea, 2.3 per cent. The culture showed *Bacterium coli*. The left ureter could only be entered for a distance of 1.5 cm., whereupon an obstruction was encountered in the repeated attempts made with ureter catheter to pass by it; the quantity of urine, however, too small for analysis, showed the presence of tubercle bacilli. On culture, *Bacterium coli* and staphylococci were found. On the basis of these findings an exploratory operation was proposed and accepted.

Operation.—An oblique lumbar incision was made and the lower pole of the left kidney was found to be on a level with the last rib and the kidney rather securely placed under the costal arch. Numerous fine adhesions were manually severed to mobilize the kidney, which on its cortex appeared normal. Whilst in the act of grasping the kidney to deliver it into the wound with gentlest of traction, an adhesion seemed to give way, followed by a profuse hemorrhage, which was controlled by pedicle clamps. The bleeding vessel could not be isolated sufficiently to apply a ligature. Advantage for the time being was taken of the hæmostasis effected by the clamps, and the kidney was split, according to Hyrtl-Zondek, from pole to pole. The bisection was naturally bloodless, and parenchyma, and *all of the kidney, to the fullest extent that it could be rendered visible in situ, showed absolutely no trace of disease.* Intending to save the kidney, it was sutured and several attempts were again made to isolate the injured vessel of the renal pedicle, which proved futile. Inasmuch as the clamps applied included so much, if not all of the vascular pedicle, nephrectomy became obligatory and ablation

FIG 1



Tubercular ulcer of pelvis of kidney. (The ulcer seen on the papilla jutting into calyx above should have been below, the ureter having been drawn in the wrong direction.)

of the kidney followed, with the clamps left *in situ*. The shocked condition of the patient and the loss of blood called for rapid work, hence no ligature was applied to the pedicle, which was short and greatly thickened by the cicatricial tissue surrounding it. The wound was tamponed with sterile gauze and the clamps removed on the fifth day. The subsequent healing of the wound was protracted over many months. This tardiness, as well as the flabby appearance of the granulations, in all probability due to an infection of the *terrain* of the operation by splitting of the kidney for inspection, emphasized anew the tuberculosis of the kidney removed.

DESCRIPTION OF THE SPECIMEN.

Macroscopic.—In the nascent state, when the kidney was still further divided so as to explore the interior of the pelvis, an irregular undermined necrotic ulceration 0.5 cm. in diameter was disclosed near the lower pole, on the tip of a papilla jutting into the lower calyx (Fig. 1). In good light, it was easily recognized that the color of the papilla was much paler and of a yellowish-white color, the markings not as discernible as in other papillæ, and the distinctions at the confines of cortex and medulla effaced.

Microscopic Examination.—Tubercle bacilli were recovered from the scrapings of the base of the ulcer. Sections about the papilla showed lymphoid reticulated stricture, with areas of poorly stained cells due to necrosis, characteristic of tuberculosis. Towards the base of the papilla the process was older, as evidenced by the increase of the interstitial fibrous tissue, which had replaced the destroyed tubules. In some of the ureter saved from the fragmentary condition of the pedicle necessitated by the exigencies of the case, distinct tubercles and giant cells were to be seen.

Epicrisis.—But for the accidental injury of the vessels, we should have improperly judged the kidney to be the seat of no tuberculous lesion, because there were no signs of such visible in the cortex or kidney parenchyma exposed to view. The subsequent findings as well as the consequent tedious behavior of the wound point to an infection of the field from the exposed diseased parenchyma.

The significant lesson to be learned from this single experience is that if ureter catheterization shows the presence of undoubted tubercle bacilli,[1] immediate nephrectomy is none the less indicated, without division of the kidney, to confirm the findings in the face of doubt arising because of the absence of superficial lesions.

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[1] This dictum does not apply to cases of tubercle bacilli eliminated in urine without urinary symptoms or signs.

In other words, the finding of tubercle bacilli by ureter catheterization is paramount to and renders superfluous subsequent exploratory nephrectomy. By such a procedure in very early cases, and all the more so in advanced tuberculosis with apparent lesions, the chances of infecting the wound and causing a tardy convalescence are reduced to a minimum.

Because of the stricture in the lower end of the ureter and the findings of tubercles in the upper ureter, and the location of the ulcer in the lower calyx, contiguous to the diseased ureter, the question might arise: Was not this an ascending tuberculosis? Against this it will suffice to point out that the entire pyramid belonging to the papilla was diseased and the changes near the base were of a fibrous character.

We can assert merely speculatively that with the tendency to stricture formation of the ureter its ultimate obliteration was likely, and this patient if not operated upon would have eventually developed a closed tuberculosis of the kidney, none the less calling for ultimate surgical intervention.

End Result.—Relief from the painful and frequent micturition followed the nephrectomy. The urine also cleared, and this amelioration remained for six months. At the expiration of this time a return of these symptoms set in, associated with a left-sided tuberculous epididymitis so acute in its development and so extensive that a castration was performed. The vas was as thick as a lead pencil and the cord structures much thickened. Though the immediate result was primary union, two months later a sinus formed which yielded admirably to treatment with the Bier cup.

In the meantime hæmaturia has appeared on several occasions, which the cystoscope showed to come from the very much engorged prostate and large vessels overlying. From the left ureter clear urine is seen to issue. Notwithstanding these complications, the patient's general health is good and he has gained 10–12 pounds.

THE SURGICAL TREATMENT OF NON-RESILIENT DIVERTICULA OF THE BLADDER.*

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THE comparative infrequency of large diverticula of the bladder has prompted me to report in detail a case which I have observed, and to review the methods employed in the surgical treatment of this affection.

While cystoscopists of experience are apparently agreed that diverticula of the bladder associated with urethral or prostatic obstruction or the presence of stone are relatively frequent, such sacculations, whether single or multiple, are usually unassociated with peridiverticular adhesions and tend to disappear after the removal of the cause of increased intravesical pressure. In this connection I wish to deal only with that form of diverticulum, usually of large capacity, which, owing to the existence of adhesions to the surrounding organs or to the paucity of the muscular element in the sac wall, is characterized by the absence of expulsive force. From the point of view of pathogenesis one should not include as true diverticula those cases which are a sequence of perivesical suppuration, although from the point of view of diagnosis and treatment they are indistinguishable from such as result from attenuation of the bladder wall through pressure.

VARIETIES.—Large diverticula may be either congenital or acquired. I am not aware of any case in which a diverticulum has been found post mortem in infancy; Pean's [1] case, however, strongly supports the congenital theory, as does a case reported by Hofmokl and Ghon,[2] especially as in the female the conditions chiefly considered as causative factors, such as urethral stricture and prostatic hypertrophy, do not exist. Nor was there found in these cases any evidence of spinal injury or disease.

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* Reported in the Surgical Section of the Canadian Medical Association, August, 1907.

SYMPTOMATOLOGY.—The variations in the symptom complex in vesical diverticula are so numerous that I have given somewhat in detail the symptomatology in each case of the series reviewed. A case reported by Murchison[3] illustrates in a striking way the occasional obscurity of the urinary relation and the difficulties of diagnosis where cystoscopy cannot be carried out. Generally speaking, however, the symptoms complained of are those of an acute cystitis, that is, pain, frequency of micturition, and the passage of cloudy, malodorous urine. Micturition may be associated with severe tenesmus. The frequency with which a tumor has been found, generally situated to one side of the median line, is noteworthy. Possibly, however, the most characteristic symptom is the ability of the patient to repeat the act of micturition after a short interval. In such cases the introduction of a catheter after voluntary urination usually evacuates a large residue. While the stoppage of the stream in the first act is no doubt due to the passage of the vesical contents in the direction of least resistance, that is, into the diverticular sac, a reversal of this process is initiated as soon as the expulsive efforts of the bladder cease, and continues until the pressure in the two cavities is equalized. Where the diverticulum occupies a dependent position there is always residual urine, and one generally fails in attempts to wash the bladder clean,—which adds greatly to the difficulties of the cystoscopist. The writer's case illustrates very well this latter point, as upon first examination, owing chiefly to the fact that the distending fluid was cloudy, the presence of a diverticulum was overlooked.

In the majority of cases there is a history of recurring febrile attacks associated with chills, with or without symptoms of renal involvement.

Where the diverticulum replaces an abscess cavity, there is of course a history of the sudden evacuation of a large amount of purulent urine. This symptom of urgency is also associated with those cases in which a sudden evacuation of the diverticular contents follows periodical occlusion of the orifice.

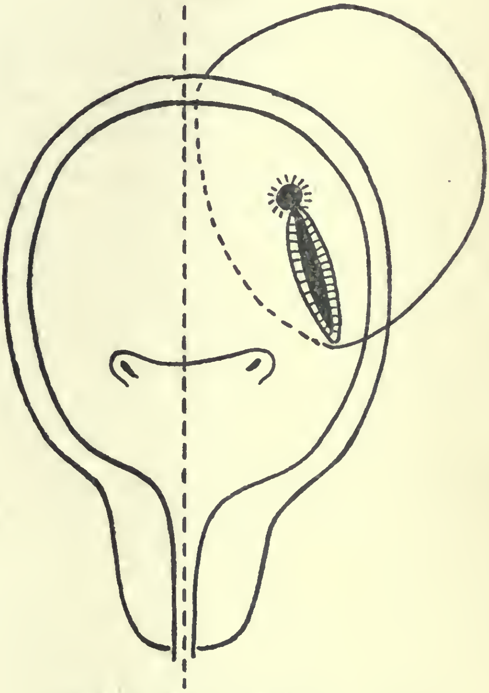
COMPLICATIONS.—The burden of the literature on this subject deals with post-mortem findings, the cardinal complications observed being severe vesical or diverticular inflammations, displacement and dilatation of the ureter, pyonephrosis, perivesical abscess, peritonitis, and femoral thrombosis. Pressure upon and deflection of the ureter above its intramural course is a frequent complication and leads eventually to dilatation of the ureter and of the renal pelvis. With the advent of infection there follows, in consequence of the ureteral obstruction, widespread renal suppuration and impairment or destruction of the renal function. In the author's case the renal symptoms were decidedly the most striking when the patient first came under observation, the presence of a diverticulum remaining unrecognized for some time. In Cases III, V, and VII of the series reviewed the diverticular orifice was found to occupy the normal site of one of the ureters, and the ureter of the corresponding side to discharge directly into the diverticulum. Careful perusal of the cases reported strongly substantiates Young's[4] opinion that this condition of affairs is due to a gradual inversion of the ureteral orifice through extension of the diverticulum and not to sacculation of the ureter itself.

TREATMENT.—*Catheterization.*—The use of the catheter for retention and irrigation is at best a makeshift, as, owing to the fact that the communication with the bladder seldom provides dependent drainage, irrigation cannot possibly give permanent relief or even free the urine from pus. There are no successful results recorded from this method of treatment.

Drainage.—Suprapubic cystostomy undoubtedly gives temporary relief and is properly undertaken in weak individuals. The absence of resiliency in the diverticulum, however, deprives this method of treatment of any permanent value. In a case reported by Burckhardt[5] a perineal drain was inserted, but the patient died.

Enlargement of the Orifice.—In considering this form of treatment the position of the diverticulum must be one's chief guide. Where the accessory sac is found to underlie the trigone of the bladder, or where the most dependent portion of the diverticulum is on a lower level than the base of the bladder, treatment by this method cannot be expected to yield a cure. Where, however, the diverticulum is in the course of the urachus, or is so placed that the incision may be carried to its lowest level and still be above the base of the bladder, it is conceivable that the result might be satisfactory, provided there remained no obstruction in the course of the urethra, either from enlarged prostate, spasm of the sphincter, or urethral stricture. As the reflection of the diverticular wall upon the outer surface of the bladder may extend for only a

Fig. 1.



Illustrating operation of enlargement of orifice.

short distance around the opening of communication, the corresponding cut edges of the bladder and diverticulum should be carefully approximated by sutures in order to forestall the danger of an extravasation into the pelvic cellular tissue. A case reported by Young[4] in which this method of treatment was followed, resulted in the re-establishment of voluntary micturition but a residual urine of 300 c.c. necessitated the use of the catheter at bedtime (Fig. 1).

Suture of the orifice of the diverticulum without excision of the sac has been practised by Pousson,[6] who reports a case in which after the mucosa of the diverticulum had been thoroughly curetted and the margin of the orifice freshened, closure was effected by means of catgut sutures. The operation is said to have been successful; but the procedure, for very patent reasons, is not to be recommended.

Complete Excision of the Diverticulum.—This would appear to be the only method yielding permanently satisfactory results. Where obstruction is present it should be dealt with primarily, or at least at the same time that the excision of the diverticulum is carried out. Further, in cases where pyonephrosis exists as a complication, and examination of the segregated urine shows extensive impairment of the renal function, it would seem rational to deal in a radical way with the complication before attempting bladder suture in the presence of a constant inflow of purulent material.

The literature contains the reports of ten cases treated by complete excision, which owing to the varied symptomatology and different operative methods employed are, in addition to the author's case, given somewhat in detail.

CASE I—(AUTHOR'S CASE, 1906).—R. F., aged 32, was first seen on October 27, 1906. His complaints were pain in the right loin, frequency of micturition, interruption of the stream, and attacks of fever. His family history was negative.

Personal History.—Since adolescence he had experienced difficulty in emptying the bladder, the act requiring as a rule several minutes. In 1897 he contracted a severe urethritis, which became chronic and was complicated at first by cystitis and later by what was diagnosed as pyelitis. Subsequently there was marked impairment of health; the urine from time to time became extremely cloudy and fetid; and frequent attacks of cystitis, occasionally complicated by retention, necessitated the use of the catheter. Throughout this period a marked irritability of the sphincter urinæ led to frequent interruptions in the act of micturition. In 1902 the patient was sent to Arizona for one year, where he subsisted largely on a milk diet with beneficial results. After his return to work he was from time to time interrupted in his vocation by attacks of cystitis, necessitating bladder lavage and the use of urinary antiseptics. In August, 1906, a severe febrile attack intervened, associated with pain in the right side. In September a second and in October a third attack similar in every way occurred. It was during convalescence from the last attack that the patient came under my observation.

On examination there was found tenderness on deep pressure in the right flank. The bladder dulness extended above the symphysis half-way to the umbilicus. The urine was cloudy, specific gravity 1.018, acid, and contained albumin, casts, and a large quantity of pus. The residual urine amounted to 200 c.c. The act of micturition was prolonged by pressure upon the lower abdomen. The evening temperature was 103° F., falling to 99° in the morning.

Digital examination of the rectum showed the prostate to be normal; the seminal vesicles were slightly thickened and somewhat tender. Above the prostate, extending to the right, could be felt a large, boggy mass which was considered to be a dilated, atonic bladder.

A cystoscopic examination by Dr. R. P. Campbell on October 30 revealed the following facts:

The bladder held 350 c.c. with but a slight feeling of distention. The bladder wall was hypertrophied and trabeculæ were everywhere visible; some cystitis was present, most marked about the trigone, but not sufficient to account for the quantity of pus present. The urethral orifice appeared normal and the ureters were easily catheterized. The right ureteral terminal was displaced towards the median line. The urine from the right ureteral catheter flowed steadily drop by drop (evidently from a dilated ureter) filling two test-tubes, while the secretion from the left side, flowing at a normal rate, filled one-half a test tube.

The urine collected by catheter from the bladder and from the two kidneys when compared showed:

	Common	Right	Left
	Turbid	Turbid	Clear
	Acid	Acid	Acid
Specific gravity	1010	1009	1025
Albumin	Present	Present	Trace only
Urea		0.8 per cent.	2 per cent.
	Pus	Pus	No pus
	Bacteria	Bacteria	No bacteria
	Blood cells		
Cultures	*B. pyocyaneus*	*B. pyocyaneus*	An occasional colony of *B. coli*
	B. coli		

Diagnosis.—Spasm of the sphincter, hypertrophy and dilatation of the bladder, chronic cystitis, dilatation of the right ureter (above the ureteral sphincter), chronic suppurative pyelonephrosis.

Rest in bed and lavage of the bladder effected within a few days a marked improvement in the patient's general condition, the evening temperature falling to 99½°. An attempt was made by means of vaccines prepared from devitalized cultures to induce a bacterial immunity to both *B. pyocyaneus* and *B. coli communis* under strict opsonic observations. Before inoculation with composite vaccine the index to *B. pyocyaneus* was 1.25; and that to *B. coli,* 2. On November 18 the indices were 2.5 and 6 respectively. At this time the temperature showed an increase in the evening registration; and, fearing a recurrence of the former severe febrile symptoms with attendant toxæmia, I decided to remove the right kidney.

On November 22 a nephrectomy was performed under ether anæsthesia. As was expected the ureter, pelvis, and calices were found greatly dilated. Secreting tissue remained in isolated areas, chiefly at the two poles; and there could be seen macroscopically numerous small abscesses throughout the gland. Cultures from the pelvis of the kidney upon agar slants yielded within twenty-four hours pure growths of *B. pyocyaneus.* Following the operation there was an immediate cessation of the pyrexia. As, however, in spite of daily irrigation of the bladder the urine continued to be cloudy, on December 5 under a general anæsthetic a suprapubic drain was inserted. On exploration of the interior of the bladder a small opening was observed to the outer side of the right ureteral orifice through which purulent material exuded. A probe thrust into this opening could be felt per rectum to pass to the posterior wall of the pelvis. The orifice of communication was found to admit readily large blunt forceps, through the open jaws of which a drainage tube 1 cm. in diameter was inserted. The anterior extremity of the tube was then sutured to the margin of the suprapubic wound.

Following this procedure the urine showed a very marked decrease in the amount of pus present. At the end of ten days the diverticulum tube was removed and at the end of three weeks the suprapubic opening was allowed to close. The temperature maintained an afebrile course. During the next two months the bladder was irrigated daily; and upon several occasions the suprapubic wound closed, only to open again in from four to six days. Throughout this period it was noticed that although micturition could be readily initiated, the stream rapidly declined after the passage of 240–280 c.c. A few minutes later the patient was able to pass a similar amount, this state of affairs being due evidently to the passage of the urine on contraction of the bladder into an accessory cavity offering less resistance than the *via naturalis*. It was further observed that if catheterization were employed, the instrument if re-introduced in ten or fifteen minutes evacuated a further amount of 180–250 c.c.

A cystoscopic examination was again undertaken and the existence of a large diverticulum demonstrated. The opening from this into the bladder was found about 2.5 cm. to the outer side of the right ureter. This cavity was further determined to be of large dimensions, probably capable of holding 200–250 c.c., as it was possible to introduce the cystoscope through the opening (1 cm. in diameter) into a cavity which appeared to be almost as large as the bladder itself.

Operation, February 28.—Extravesical, extraperitoneal excision of the diverticulum; re-establishment of suprapubic drainage.

Under ether anæsthesia a vertical incision was made through the lower segment of the right rectus muscle. The peritoneum was readily stripped back to the upper margin of the diverticulum; but owing to the close adhesion of the wall of the accessory cavity to the outer surface of the bladder for some distance from the opening of communication, it was found impossible to isolate the neck of the sac without re-opening the suprapubic wound. With the tip of the left forefinger passed through the orifice of the diverticulum and used as a retractor and guide, the separation of the diverticulum from the bladder was readily effected. After the neck of the sac had been divided, the bladder was closed extravesically by means of a purse-string suture. This was reinforced and the bladder wall further inverted by a continuous catgut suture. The enucleation of the sac presented little or no difficulty. It was found to extend below for a considerable distance undermining the trigone, behind to the posterior wall of the rectum and laterally to the pelvic wall. Drainage of this cavity was provided by means of a rubber tube passed behind the prostate and through the perineum without communicating with the urethra. Complete closure of the lateral suprapubic incision and partial closure of the suprapubic wound after excision of scar tissue concluded the operation. Intravesical pressure was provided against by means of a small suprapubic siphon. Convalescence was rapid and uninterrupted. The perineal drain, which was apparently unnecessary, was removed on the third day; and at the end of three weeks, after I had determined by cystoscopic examination through the suprapubic wound that the diverticular opening was firmly united, the suprapubic siphon was removed.

A microscopic examination of the excised diverticulum showed the wall to consist of several layers of flattened cubical epithelium; a well-defined submucosa; muscle bundles running in various directions; and externally a layer of loose connective tissue.

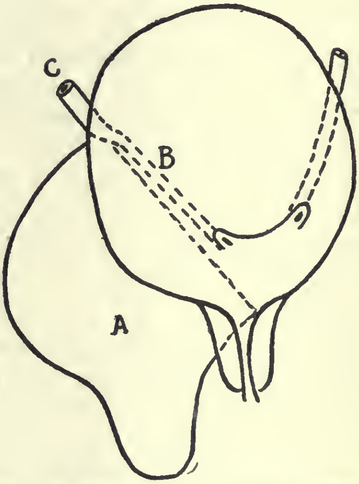
Owing to the recurrence from time to time of a suprapubic fistula, the patient was given an anæsthetic on May 18, and the sphincter urinæ dilated to 42 F. with a Kollmann instrument. The suprapubic wound closed finally within ten days.

On June 15 the patient was discharged well. The urine at this time was clear and contained but few pus cells and bacteria. The residual urine varied between one and two ounces.

Subsequent History.—Apart from a mild attack of prostatitis in May, 1908, at which time there was a residual urine varying between one-half and two ounces, the patient has been free from urinary symptoms.

Remarks.—In reconsidering this case in detail, I am of the opinion that the diverticulum was most likely congenital in origin, although I am aware that this is not capable of proof; the early symptoms, however, support this view. With such a condition existing an infection alone was necessary to produce the subsequent train of symptoms; this in time arrived. It is further probable that infection of the kidney was favored by the pressure of the diverticulum upon the ureter at some little distance from its vesical orifice. This theory would also account for the extreme dilatation of the ureter without involvement of its vesical terminal.

Fig. 2.



Illustrating author's case. *A*, diverticulum; *B*, displaced ureter and ureteral orifice; *C* dilated ureter above intramural course.

If the diverticulum were of recent development, the spasm and hypertrophy of the sphincter must be considered the etiological factor, as they furnished sufficient obstruction to produce sacculation. As an illustration of the degree of obstruction produced by the sphincter, one has only to recall the repeated failures to close the suprapubic wound (Fig. 2).

ABSTRACT OF CASES.

Case II (Pean,[1] 1895).—Congenital vesical diverticulum and supernumerary urethra in a girl aged fifteen. There had been incontinence from birth. On examination there was found on the anterior wall of the vagina a median protrusion the size of a nut. On digital pressure over the tumor urine was seen to escape from a narrow opening placed in the median line 3 mm. below the external orifice of the urethra. On the supernumerary external orifice being obstructed with the finger and pressure again exerted, there was a gradual diminution in the size of the tumor and the patient complained of a desire to urinate. Under a general anæsthetic an incision was made over a director along the anterior wall of the vagina, the diverticular tract excised, and the opening into the bladder sutured. The patient was cured.

CASE III (CZERNY,[7] 1896).—A young man, aged 31 years, developed after traumatism a stricture of the membranous portion of the urethra, followed by retention, cystitis, and pain in the region of the left kidney. On examination there was found to the left of the median line a tumor the size of a child's fist which on compression discharged its contents into the bladder. Suprapubic cystostomy disclosed a greatly thickened bladder with a finger-shaped prolongation towards the navel. In the region of the left ureteral orifice a large diverticulum was demonstrated, the opening of communication admitting the finger. The accessory sac completely filled the small pelvis, and contained foul urine and epithelial detritus. Suprapubic drainage was continued for a fortnight without freeing the urine from pus, and excision of the diverticulum was decided upon. The left rectus was incised transversely. Many adhesions were encountered, especially in the region of the rectum and in the hollow of the sacrum. During the operation the peritoneum and the left ejaculatory duct were injured. The left ureter was dilated and passed obliquely through the wall of the diverticulum. It was divided and implanted into the bladder wall. The wall of the excised diverticulum contained muscular and epithelial elements. Convalescence was retarded by the formation of a ureteral-abdominal fistula. Four months later the left kidney, the seat of pyonephrosis, was extirpated. At the time that the patient was discharged, the bladder held 150 c.c. and he was able to retain his urine from two to three hours.

CASE IV (RIEDEL,[8] 1903).—The patient, aged 61 years, was admitted to the Surgical Clinic in Jena on December 20, 1902. He had experienced difficulty in urinating for three years. Latterly the use of a catheter had been necessary. On examination there was found marked enlargement of the prostate. Prostatectomy was performed. Five months later, in May, 1903, symptoms of obstruction returned, with pain in the right side above Poupart's ligament, for the relief of which a perineal section was performed. On June 13, 1903, suprapubic cystostomy revealed the presence of a large diverticulum communicating with the bladder through an opening 2 cm. in diameter. The bladder was closed and a second incision made through the right rectus muscle. The accessory sac was excised and the communication with the bladder closed with catgut suture. Perineal drainage was re-established. Collapse and death occurred on the following day.

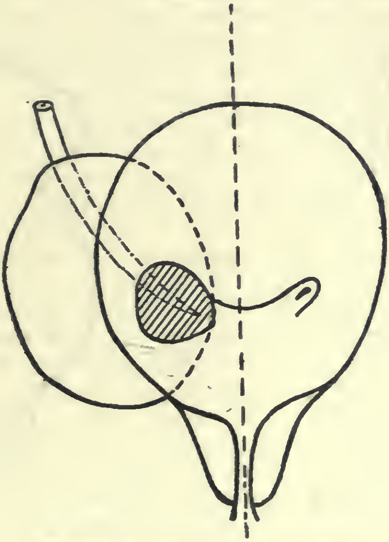
CASE V (PAGENSTECHER,[9] 1904).—The patient, a male aged 33 years, was seen in August, 1903. During the preceding winter he had suffered for two or three days from pain in the bladder and on micturition. Five weeks later the pain had returned with strangury and tenesmus every half hour. On admission the distended bladder could be felt above the pelvic brim. After evacuation with a rubber catheter, a solid instrument when introduced withdrew a further amount of turbid, bloody urine, and the abdominal tumor disappeared. On subsequent irrigation the bladder was found to hold as much as one litre. Cystoscopy was unsuccessful; and on August 30, 1903, suprapubic exploration was undertaken. In the position of the left ureter was found the opening of a large diverticulum.

As there was no improvement in the patient's condition following drainage, extirpation of the diverticulum by the sacral route was carried out on December 16. The left ureter, which opened into the accessory cavity, was implanted into the bladder at the former opening of communication. A self-retaining catheter was placed in the urethra. The excised sac contained in its walls bundles of smooth muscle fibres running in various directions and a well-marked submucosa. Of the epithelial lining only a few fragments were preserved, In addition to a sacral fistula the suprapubic wound continued to discharge for some time. In February both fistulæ had healed, but in March the sacral fistula reopened, urine escaping during micturition.

CASE VI (VON EISELSBERG,[10] 1904, reviewed by CHRISTIE).—In the discussion upon Pagenstecher's paper, von Eiselsberg reported a case of vesical diverticulum which had come under his observation, in which a palpable suprapubic tumor disappearing under pressure was followed by a desire to micturate. The presence of a diverticulum was confirmed by cystoscopic examination, the orifice of communication with the bladder being situated at the base. Excision of the sac was successfully practised. Details as to operative procedure and histological examination of the sac wall are not given.

CASE VII (YOUNG,[4] 1904).—The patient, a male aged 30 years, was seen in January, 1904, complaining of frequency of micturition and pain in the back. There was a history of severe attacks of urethritis in 1893 and 1898. During the last attack a tight stricture in the bulbomembranous region was found to exist, for the relief of which a combined external and internal urethrotomy was performed. During the next three years the patient was free from urinary symptoms. About April, 1902, he had an attack lasting one week, characterized by obstruction and frequency of micturition. Three months later a second attack similar in every way occurred. In September, 1903, a third attack supervened, and in October a fourth attack with pain in the right side of the pelvis and severe tenesmus culminated in the sudden passage of a quantity of pus. It was thought that an abscess had ruptured into the bladder. Although retention occurred, a catheter could be passed without meeting with obstruction. Bladder lavage was practised without diminution in the amount of residual urine. On December 9 pain and tenderness developed in the right flank beneath the costal margin. On January 4, after coming under observation, the patient had a similar attack lasting several hours, which necessitated the use of morphine. At this time fever, nausea, and the presence of muscular rigidity over the right kidney were observed. Examination showed the prostate to be slightly harder than normal, but there was no evidence of stricture. There was a residual urine of 350 c.c. The bladder was washed clean with difficulty. Pressure on the lower abdomen was necessary to evacuate completely the bladder contents. The cystoscope revealed a large diverticulum with an orifice of communication 2 to 3 cm. in diameter, situated in the position of the right ureteral opening. The left ureteral orifice was found displaced towards the left, with the opening of a second and smaller diverticulum lying above and to its outer side. The right ureteral orifice, of course, could not be seen, but it was subsequently found to open upon the inner wall of the larger diverticulum. For six weeks catheterization and lavage were practised, but without diminution in the size of the diverticulum or in the quantity of residual urine.

Fig. 3.



Illustrating Case VII (after Young).

Operation, February 10. Suprapubic extravesical excision of the large diverticulum with closure of the orifice was carried out; also drainage of the bladder through a perineal urethrotomy and drainage of the retrovesical space by means of a tube passed behind the prostate and through a posterior perineal incision without entering the urethra. The intradiverticular emplacement of the right ureteral orifice was brought forward by means of a flap operation (Fig. 3).

Owing to the failure of the suprapubic wound to heal, the presence of 30 c.c. of residual urine, and the recurrence of a small pouch at the site of the excised diverticulum on the right side—all indicating obstruction—a Bottini operation was performed on August 4.

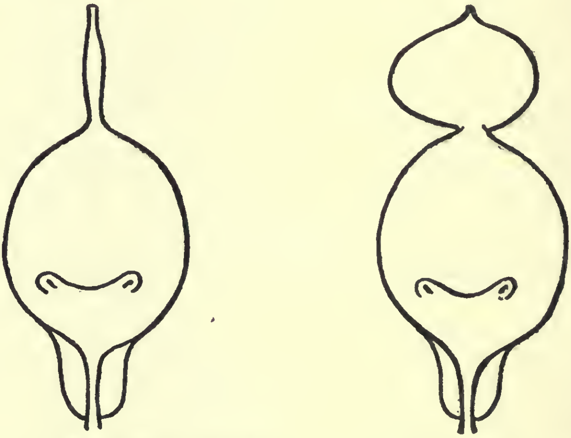
Examination of the wall of the excised diverticulum showed the presence of an epithelial lining and numerous layers of smooth muscle-bundles running in various directions. There was also present the usual evidence of chronic inflammation.

Five months after operation the patient reported his urine to be clear and the function of urination normal.

CASE VIII (YOUNG,[4] 1904).—Male, aged 34 years, was admitted to the Johns Hopkins Hospital on January 18, 1904. In March, 1899, the patient jumped from a moving locomotive, striking upon the buttocks. Following the accident he felt severe pain in the lower portion of the abdomen, and on examination found a lump about the size of a hen's egg below and to the left of the umbilicus. This swelling gradually subsided. There was, however, a return of the pain at the site of the tumor if the bladder were allowed to become distended.

On cystoscopic examination there was found in the region of the vertex the small orifice of a diverticulum. The bladder wall was not trabeculated.

FIG 4.



Diverticula in the course of the urachus (after Young).

Operation, January 28. Excision of a small diverticulum lying within a dilated urachus. On February 23 the patient was discharged well (Fig. 4).

CASE IX (YOUNG,[4] 1903).—Male, aged 63 years, was seen in February, 1903. In 1901 the patient first noticed frequency of urination and difficulty in starting the stream. At the time of admission urine was voided about every fifteen minutes. The patient had never had complete retention and a catheter had never been used.

On examination the urine was found to be normal. The prostate was moderately enlarged. On passing a catheter 1200 c.c. of residual urine was withdrawn. Cystoscopic examination showed intravesical prostatic hypertrophy, moderate trabeculation of the bladder wall, and on the right side anteriorly the opening of a diverticulum.

Operation, February 22. Suprapubic extravesical extraperitoneal excision of the diverticulum with suture of the orifice of communication; perineal prostatectomy. Enucleation of the diverticulum was effected without difficulty owing to the absence of dense adhesions. The capacity of the diverticulum was estimated at 500 c.c. The bladder itself was not opened. The patient was discharged well on the twenty-seventh day following operation.

Microscopically the mural elements consisted of well-defined mucous, submucous, and muscular layers. There was no evidence of inflammation.

CASE X (PORTER,[11] 1907).—This patient, a male aged 34 years, first came under observation in April, 1906, complaining of difficulty in starting the stream, of frequency of micturition, and of the passage of foul urine which occasionally contained clotted blood. On examination the bladder was found to extend to the umbilicus. The residual urine varied from 19 to 24 ounces. Treatment at this time was declined. When the patient returned one year later, digital examination of the rectum showed the prostate to be moderately enlarged and cystoscopy revealed the presence of three diverticula, one of which was especially large, with its orifice of communication situated at the right side of the base of the bladder.

On April 30 suprapubic drainage was established. On May 21 the bladder was reopened suprapubically, and the sphincters of the diverticula widely dilated. The patient was discharged in August, but leakage still occurred from the suprapubic wound.

He returned in September suffering from epididymitis and pain in the region of the left kidney.

Operation, September 8. An incision was made parallel with Poupart's ligament. The peritoneum was opened and an elastic swelling the size of a banana, extending backward and to the left of the base of the bladder, was found. In order to separate the accessory sac from the rectum the bladder was again opened and the forefinger inserted into the diverticulum as a guide and retractor. The orifice was closed with two layers of catgut sutures. Suprapubic drainage was provided and a rubber catheter placed in the urethra. At the end of October the patient was reported to be much improved in health, but in the absence of urethral drainage leakage still occurred at the site of the bladder suture.

CASE XI (WULFF,[12] 1904).—The patient, a male aged 34 years, first experienced difficulty in micturition in May, 1903. In July, while confined to bed, he suddenly lost the power of voluntary urination. A large quantity of urine was withdrawn by catheter. Although voluntary micturition was subsequently restored, there remained a residue of one litre which, however, did not produce discomfort. The condition was at first thought to be due to a disturbance of the sensory nerve supply. On examination some months later there was found in the right lower quadrant a large tumor, which catheterization failed to reduce but which on pressure suddenly discharged into the bladder a large quantity of fetid, brownish-yellow fluid. Cystoscopy showed the presence of a diverticular opening on the right side.

Operation.—An incision was made parallel with Poupart's ligament, the peritoneum stripped back, and the diverticular sac opened and evacuated. The cavity was then tamponed.

Three weeks later the sac was resected and the orifice of communication with the bladder sutured. Intravesical tension was provided against by means of a permanent urethral catheter.

Several weeks later, owing to the failure of the bladder suture line, the opening into the bladder was again exposed and the edges freshened and resutured. At the end of a further period of several weeks the patient was discharged. The wound had healed. The urine, voided spontaneously every three hours, was for the most part clear. There was a residue of 150–200 c.c. On cystoscopic examination the mucous membrane at the site of the suture was found to be firmly united. Whether the presence of the residual urine was due to atony of the vesical wall following the prolonged distention, or whether due to defective enervation, had not been determined. The wall of the excised sac contained epithelial and muscular elements.

Etiology.—Of the series of eleven cases reviewed, I, II, V, VIII, X, and XI belong to the congenital variety, although positive evidence of congenital origin can be said to exist only in Case II, reported by Pean.[1] In this connection it is fallacious to lay too much stress upon the presence of bladder epithelium and muscular tissue in the wall of the accessory sac, as these elements may be present in cases where prostatic hypertrophy has been considered the etiological factor (IX) and also in cases in which a urethral stricture has existed (III and VII).

To prostatic enlargement may be ascribed the development of the diverticulum in Cases IV and IX. Porter's[11] case may belong to this category. The note on the prostatic condition is not very definite. While the age would suggest a congenital origin, it does not exclude a prostatic causation.

Urethral stricture was present in Cases III and VII. Owing to the persistence of obstructive symptoms (that is, pouching of the suture line and residual urine) after extirpation of the diverticulum, a Bottini operation was performed in Case VII with permanently satisfactory results.

The etiological factor in the case reported by the writer must remain in some doubt; the history on the one hand suggests the possibility of the diverticulum having been congenital, while on the other the presence of hypertrophy and spasm of the sphincter urinæ cannot be left out of consideration.

Traumatism was undoubtedly the exciting cause in Case VIII. The urachus had probably remained patent from birth.

Perivesical suppuration has to be considered as possibly the precursor of the diverticulum in Case VII, in view of the history of a sudden evacuation of a large quantity of pus. Opposed to this theory are the facts that a stricture had existed in the bulbomembranous portion of the urethra and that the diverticulum was lined with epithelium and contained muscular elements in its wall.

While no case of diverticular formation secondary to congenital stricture of the meatus urinarius has been reported, the possibility of this condition figuring as an etiological factor should be borne in mind.

Phimosis was associated with the formation of a vesical diverticulum in a child 21 months old, observed by Lennander [13] and cited by Young.[4]

Spinal injury or disease as an etiological factor was first suggested by Hale White.[14]

Von Eiselsberg's [10] case (VI), owing to the absence of details, cannot be classified.

Age.—It will be seen from the foregoing that. apart from Cases IV and IX (prostatics, aged 61 and 63 years respectively) and the case reported by Pean,[1] all those included in our series occurred in individuals between the ages of thirty and thirty-four. This fact is most striking and suggests the possibility that they were all congenital in origin; that is to say, even the two cases with a history of pre-existing stricture present features which bring a congenital hypothesis within the limit of reason.

Prognosis.—Out of the eleven cases reviewed. the operation of excision of the diverticulum was followed by the restoration of the normal function of urination in eight instances. In two cases urinary fistulæ persisted at the time of their being reported, and in one case the operation was followed by collapse and death. The age at which the majority of these cases occur imposes a grave responsibility upon the surgeon. With modern methods of investigation, physical, biological, and chemical, applicable to the urinary tract, a correct diagnosis should practically always be made early in the affection, and with a method of procedure well established these cases should be accorded a favorable prognosis.

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FIBROLYMPHOSARCOMATA OF BOTH URETERS METASTATIC TO A PRIMARY LYMPHOSARCOMA OF THE ANTERIOR MEDIASTINUM OF THYMUS ORIGIN.*

BY BOND STOW, M.D.,

OF NEW YORK,

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MALIGNANT neoplasms of the ureters, whether primary or secondary, are of rare occurrence. Sarcomas are particularly so, there having been collected by Albarran in all only eleven cases, four of which, upon critical examination, may be excluded. Of the remaining seven cases the sarcomas of the ureter in each case were connected either with the pelvis of the kidney or the bladder. In the present case there is no involvement whatever of any other portion of the genito-urinary tract nor of the immediately adjoining tissues of the peritoneum, the neoplasms being confined strictly to the ureteral tissues. In this latter respect, after a painstaking research of the literature, it appears to be the first recorded case of its kind.

In brief, the following is the history of the case:

V. R., female, single, 27 years of age, a nurse, was admitted to the Metropolitan Hospital on August 15, 1908. Until three years ago she had been always in excellent health. Had no hereditary diseases. Venereal history denied. Excellent habits. Her present illness began by sharp pains in the upper half of the sternum and back of the neck, radiating down both arms. In November, 1905, she first noticed an enlargement of the glands over the left clavicular sternal joint. The glands were at first soft, later becoming very hard, and painful upon pressure. Shortly all the superficial glands over the body became similarly involved. Extreme emaciation, dyspnœa, dysphagia and unbearable pains all over the body forced her to seek the hospital. Her skin had an ashy, cachectic appearance common to malignant disease. During her stay at the hospital her temperature ranged from 97° F. to 101.3° F., usually registering about 99° F. The pulse rate was continuously high—highest 140, lowest 80, average 116. Respiration: highest 36, lowest 18, average 26.

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* Read before the Genito-Urinary Section of the New York Academy of Medicine, February, 1909.

Urinalysis was negative. Blood analysis showed constantly a polymorphonuclear leucocytosis. At no time during her entire illness was there any symptom complained of that pointed to the genito-urinary sphere. From September 13 the patient sank rapidly. On the day of her death, November 18, 1908, she had two general convulsions, each lasting about two minutes.

Autopsy.—The body presented the usual signs of death; all the superficial lymphatic glands were enlarged, firm, confluent and non-adherent to the skin. Beneath the acromial end of the left clavicle, to the right of the axilla, was a hard lobular tumor mass lying beneath the pectoralis minor about the size of an average orange. This tumor was not connected with either the ribs or pleura. Over the sternal end of the left clavicle was a similar tumor mass.

The abdominal cavity contained about 500 c.c. of clear, pale amber transudate, free from any inflammatory products. The omentum was studded with small grayish white hard nodular masses averaging from 1 to 2 cm. in diameter. The mesentery and mesenteric glands were involved in new growths ranging from a millet seed to 5 and 6 cm. in diameter. The peritoneum was studded with similar tumor masses of various sizes. The stomach, and the intestines, both large and small, were normal. The retroperitoneal glands along the abdominal aorta were extensively involved in metastatic new growths. At the lower pole of the spleen was a metastasis 3.5 x 3.5 x 2.5 cm., sharply outlined from the surrounding territory. In the center of the spleen were similar metastases. *The liver presented no metastases;* it was amyloid. The pancreas was embedded in a mass of enlarged glands which had in some places invaded the pancreas structure. There were no metastases in the pancreas. Uterus and vagina normal. At the fimbriated end of the right tube there was a small metastatic tumor about 4 mm. in circumference. Along the left tube, about 2 cm. from the left horn of the uterus, was a similar tumor about 3 mm. in diameter. Both pleural cavities contained about 800 c.c. of a pale amber-colored transudate. The pericardial sac contained 120 c.c. of same. The heart was normal except for presence of small degree of fatty degeneration.

Primary Tumor.—The superior third of the anterior mediastinum was entirely filled with a firm resistant tumor mass compressing the base of the heart and the œsophagus. This tumor had involved in its growth the anterior border of the upper lobe of the left lung and the upper half of the pericardium. The tumor mass appeared as though of one growth and not the union of several smaller growths. Section of this tumor mass showed extensive involvement of lung and posteriorly of the bifurcation of the trachea and larger bronchi. The tumor was exquisitely alveolar in structure and very firm in consistency. It was grayish white in color with numerous yellowish areas of fatty degeneration. Several areas had become necrotic. Nowhere could any remains of the thymus gland be found. The deep cervical glands were extensively involved on both sides of the neck.

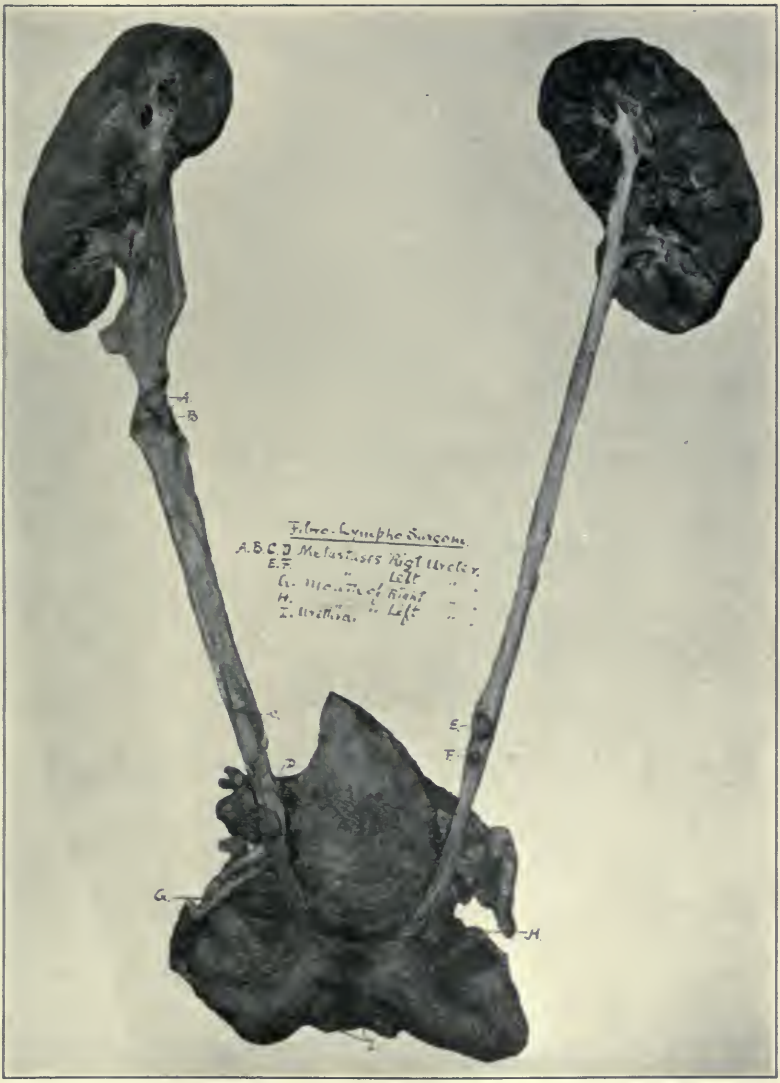
Cross section of the (secondary metastatic) glandular tumor masses (as the cervical, axillary, posterior mediastinal), showed them to be characteristic of the anterior mediastinal tumor. Over the costal pleura of upper lobe of the left lung, and along the lower margin of the lower lobe were numerous small metastatic growths. At the base of the upper lobe of right lung was a small metastatic tumor. Likewise in the center of this lobe were two metastatic tumors about 1 cm. in diameter. Along the inferior margin of the middle lobe was a fringe of small tumors. The bronchi and bronchioles contained a yellow mucopurulent secretion, and were intensely congested. The upper half of the pericardium anteriorly was firmly adherent to the main tumor of the anterior mediastinum. The epicardium was not involved. Both tonsils and the thyroid were normal. The œsophagus was normal throughout. At its middle third it was greatly compressed by the enlarged mediastinal glands. The larynx and trachea were normal.

Genito-Urinary Tract.—The bladder and urethra were normal. The exits of both ureters into the bladder were normal and measured 5 mm. in circumference. Located 3 cm. from the bladder end of the right ureter was a sharply defined, circumscribed, grayish white, firmly resistant tumor oblong in shape 1 cm. x 7 mm. x 5 mm. (*D,* Fig. 1). This tumor was strictly confined to the coats of the ureter, the peritoneal surface not being involved. The mucous membrane of the ureter directly over the tumor was destroyed, being substituted by the tumor structures itself. The mucous membranes on either side of the tumor was normal. The circumference of the ureter immediately below this tumor measured about 7.5 mm. Eighteen mm. above this tumor was a second tumor (*C,* Fig. 1) 2 cm. x 1 cm. x 5 mm., in every respect corresponding to the first one. The circumference of the ureter immediately below this tumor was 8 mm. The circumference immediately above was 17.5 mm. Ten centimeters above this second tumor was a third one (*B,* Fig. 1) 1.5 cm. x 1 cm. x 4 mm., and immediately above this one in immediate proximity, was a fourth tumor measuring about 7 mm. in diameter (*A,* Fig. 1). These latter two tumors in structure and appearance corresponded with the two lower down. The two upper tumors formed considerable of a stricture, the circumference of the ureter immediately below the upper pair of tumors being 2 cm., and immediately above 2.5 cm. The circumference of the ureter at the pelvis of kidney measured 3 cm. The pelvis of kidney was considerably dilated. Its mucous membrane was smooth, glistening and transparent. The mucous membrane of the entire ureter was apparently normal.

The right kidney was very firm in consistency, of a grayish brown color, and measuring 11.5 x 4.5 x 3.5 cm. The capsule stripped readily and surface of kidney was generally smooth. Upon cut surface the cortex measured about 5 mm. in diameter. Markings somewhat effaced. By transmitted light the cortex had a more or less semi-opaque ground-glass appearance. The pyramids showed a like appearance. Located in the capsule were numerous sharply defined grayish white homogeneous tumor masses that in no way involved the kidney structure. At the hilus of the kidney was one such about 1.5 cm. in diameter, but like those on surface of capsule did not extend on to and involve the kidney structure itself.

Located 7 cm. above the bladder end of the left ureter was a tumor 5 x 3 mm., likewise lying strictly within the coats of the ureter and not involving the peritoneal covering, in all respects

FIG. I.



Metastatic sarcomata of both ureters. Reduced one-half natural size.

similar to those of the right ureter (*F,* Fig. 1). Five mm. above this tumor was a second one 1 cm. x 5 mm. of same characteristics as first (*E,* Fig. 1). The circumference of the ureter immediately below the first tumor was 7 mm. The circumference between the two tumors was 1 cm. The circumference immediately above the second tumor was 1 cm., and likewise the same to the pelvis of the kidney which was not dilated and in every respect presented a normal appearance. The left kidney presented about the same characteristics as described for the right kidney. There was no evidence of hydronephrosis. The mucous membrane of the entire left ureter appeared smooth, glistening and transparent.

Diagnosis.—Primary fibrolymphosarcoma of anterior mediastinum, involving left lung and pericardium. Metastatic sarcomas of the cervical, supraclavicular and infraclavicular mesenteric, retroperitoneal and inguinal glands. Metastatic embolic sarcoma of lungs, spleen, fallopian tubes and *ureters.* Amyloid degeneration of liver and kidneys. Chronic bronchitis.

Microscopical Examination.—Microscopical examination of the primary tumor showed evidence of Hassal bodies, thus stamping the origin from the thymus gland. It also showed excess of fibrous connective tissue and mixed sarcomatous cells, large and small round and numerous giant cells, the small lymphoid cells predominating. Eosinophile cells were not present. The same characteristics were present in the metastatic tumors except the absence of Hassal bodies.

There are two striking occurrences in the pathology of this case—one positive and one negative. First, why were there metastatic tumors in the ureters only, and none in the kidneys? and, secondly, why were there no metastatic tumors in the liver when the mesentery and retroperitoneal glands are so extensively involved? The question of the metastases of malignant tumors is an extremely interesting one, and it seems by comparison with other similar pathological studies—as the metastatic abscesses in the cases of pyemia and the secondary growths in the cases of the infective granulomata—that one must accept the truth of the theory of the *predilection of tissues.* Else how are we to explain the frequent occurrence of metastatic tumors confined to the osseous system following primary malignant tumors of the prostate, or the predilection of the cerebral tissues for metastases of primary fibro-adenomata of the mammary gland? In the case herewith presented it is scarcely probable that no aberrant malignant cells had been brought to the kidneys or liver in a blood stream so enriched thereby. For examination of the capillaries of many of the internal organs shows abundance of metastatic sarcomatous cells.

There seems to be no other explanation of the negative findings in the liver and kidneys in this case other than that these tissues were capable of destroying the malignant cells that undoubtedly had been brought to them. How far the presence of amyloid degeneration in these two organs may have influenced the capability of the aberrant sarcomatous cells to grow therein must at present remain a speculative question.

The author acknowledges his thanks to Mr. Charles Brush for the excellent photograph illustrating this report.

CONGENITAL UNILATERAL ABSENCE OF THE UROGENITAL SYSTEM.

BY DONALD GUTHRIE, M.D.,
Clinical Assistant in St. Mary's Hospital.

AND

BY LOUIS B. WILSON, M.D.,
Pathologist and Director of Laboratories in St. Mary's Hospital, Rochester, Minnesota.

Clinical Report by Dr. Guthrie.—The following case is reported because of its anatomical and surgical interest. There are many cases reported in the literature of congenital anomalies of the female urogenital system involving one or more of its parts, such as imperforate hymen, atresia of the cervix or vagina, unicornate and bicornate uteri, double vaginæ, and, more rarely, the absence of the tube and ovary or kidney and ureter on one side occurring separately or together. Few of these cases have required surgery, except the cases of imperforate hymen, and the atresia of the vagina and cervix, which have been relieved by plastic operations upon the vaginal outlet or the cervix. One anomaly which has been observed, of a somewhat similar nature to the case reported, is a bicornate uterus, one side only of which communicated with the cervix and vagina, with the normal menstruation from that side, while the non-communicating side gradually filled with blood, forming a painful suprapubic tumor of the corresponding side. Five examples of this congenital condition have been operated upon at St. Mary's Hospital. In the majority of the cases reported, the conditions have been found during routine examinations, at operation, or at postmortem, and have been recorded because of their anatomical interest. From the conditions found in this case, we believe that the life of the patient would have been in serious jeopardy had not surgery intervened.

Case 28914.—Mrs. P., aged 30. *Family history* negative.

Personal History.—Married two years; has never menstruated, but has had, since 14 years of age, peculiar symptoms at four-week intervals which she has regarded as her periods. These symptoms have been cramping, bearing down pains through the lower abdomen, backache, and headache. There has never been any vicarious bleeding.

Previous Diseases.—Tuberculous arthritis of the right hip when 8 years of age, leaving two inches of shortening and accounting for the deformity the patient presents (Fig. 1).

Present Illness.—Four months ago, at a period when she thought she should have been menstruating, the patient had an attack of severe cramping pain through the lower abdomen, which confined her to bed for one week. At the next period, four weeks later, the cramps returned and were much more severe, followed by tenderness over the whole right half of the abdomen. She was in bed two weeks, and it was at this time the tumor was discovered and operation advised and accepted. A letter from the attending surgeon states that on exploration he found a tumor, which he believed to be the uterus, devoid of attachments on the left side. The right side of the tumor was densely adherent, with attachments as high as the liver. The operation at this time was abandoned for fear of causing the immediate death of the patient. He suggests that the tumor was a deformed uterus filled with retained menstrual blood. The recovery from the operation was good and there were no symptoms until three weeks ago, when the cramping pain returned and has continued, the patient being confined to her bed most of the time since.

Examination.—Poorly-nourished female, short stature. Scoliosis, due to shortening of the right leg. Heart and lungs negative. Tumor palpable in right half of abdomen, extending from symphysis pubis to right costal arch, which is very near the crest of the ilium because of the scoliosis (Fig. 1). Tumor is fixed and tender.

Pelvis: Rudimentary labia majora, labia minora absent. Complete absence of the vagina, urethra easily admits the examining fingers, and a tumor can be felt high up in the pelvis, lying to the right.

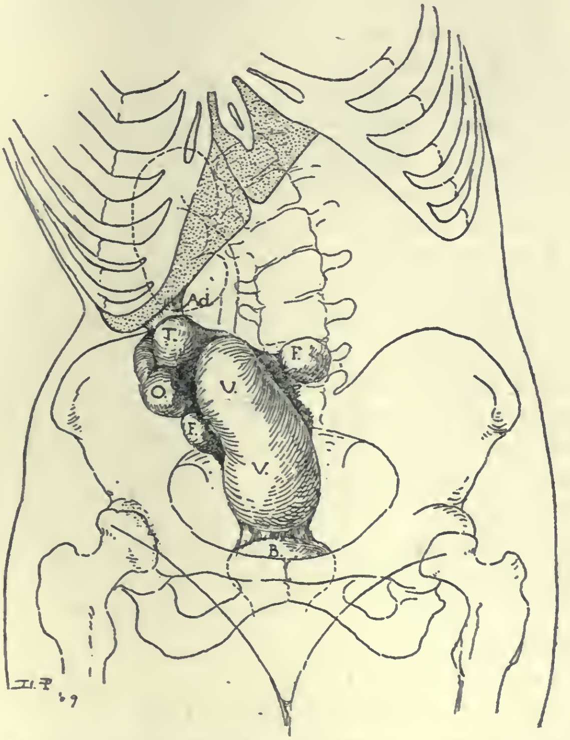
Blood: Hæmoglobin 70 per cent.; reds 3,800,000, whites 9,500.

Urine: 1016; alkaline; albumin, trace. Microscopic: erythrocytes.

Cystoscopic examination by Dr. W. F. Braasch: Urethra dilated, bladder normal size, left meatus absent. Dr. Braasch suggests the possibility of but one kidney (right).

Diagnosis.—Abdominal tumor—uterus? Congenital atresia of vagina (absence of left kidney and ureter?).

Fig. 1



Showing location of tumor. *U*, uterine portion; *V*, vaginal portion; *T*, fallopian tube; *O*, ovary; *FF*, fibroids; *Ad*, adhesions to liver; *B*, bladder with adhesions to closed end of vagina. The enlarged right kidney with absence of left kidney and ureter is indicated Incidentally also the right hip-joint disease and lateral scoliosis are shown.

Operation, January 28, 1909 (W. J. Mayo).—Tumor (Fig. 1), found to be the uterus, 18 cm. long and 9 cm. at its lowest widest portion, adherent below to the bladder and above to the under surface of the liver by adhesions to the right tube, which was distended. The ovary was cystic. There was an absence of the tube, ovary and broad ligament on the left side and of the left kidney and ureter. The tumor was very adherent and removed with difficulty. Recovery was uneventful and a recent letter from the patient says she is enjoying good health.

It was not until the specimen was opened in the laboratory that the true condition of affairs was learned, it being supposed at operation that the whole tumor was uterus and that there was a complete absence of vagina.

Microscopical sections taken from the lower portion of the tumor (Fig. 2) proved the pathologist's belief—that the lower portion of the tumor was the upper portion of the vagina and not cervix—to be correct.

That there should have been a space of 10 cm. between the closed end of the vagina and the perineum is an interesting feature in the case, showing that, originally, only a small part of the vagina was formed and, as the organ grew and filled with blood it followed the line of least resistance and was forced upward into the abdomen.

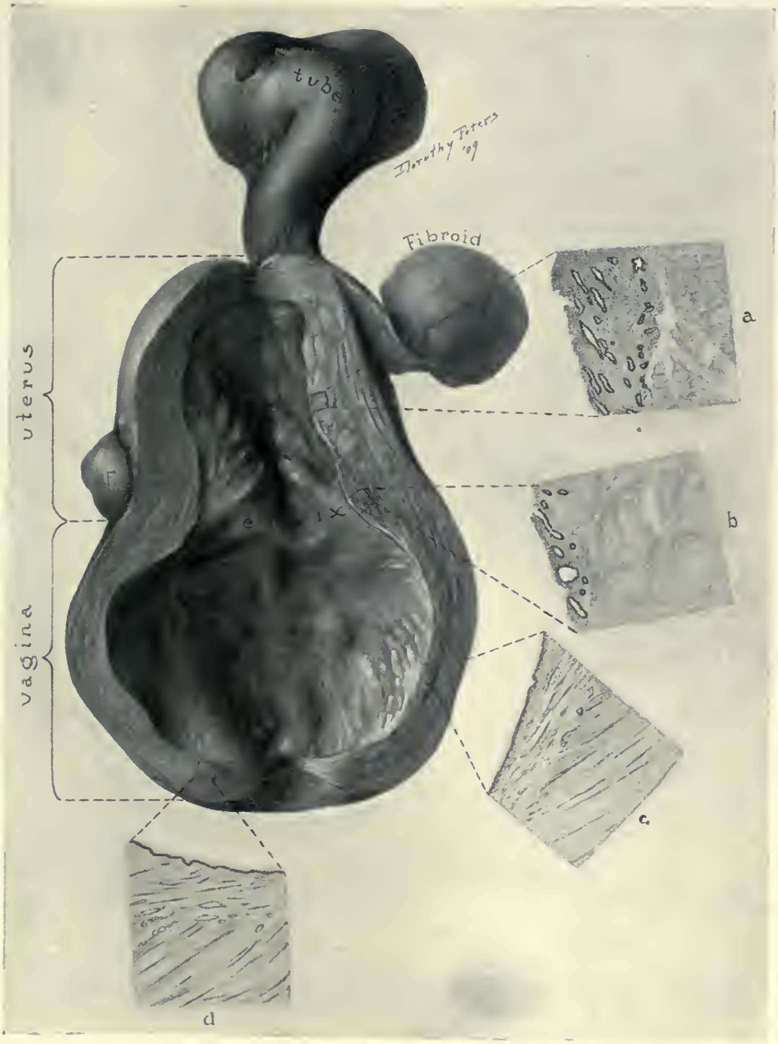
From the structure of the walls of the tumor it would appear that it had been one of long standing, although the immediate symptoms were acute for the past four or five months.

In a talk with the husband of the patient it was learned that the sexual act per urethram was accomplished at first with very little difficulty, and that coitus had always been gratifying to the patient. There had never been any incontinence of urine, and only a hint of cystitis at one time—six months before the first operation—when there was some frequency of urination, which disappeared after a short time.

Pathological Report by Dr. Wilson.—January 28, 1909, there was received in the pathological laboratory from the surgical service of Dr. W. J. Mayo, a specimen from Case No. 28914 the clinical data of which is detailed above by Dr. Guthrie.

The specimen consisted of an irregular ovoid mass 18 cm. in length and 9 cm. in its greatest transverse diameter. External examination showed the tumor to consist of what was apparently a distended uterus with closed cervix, and with but one tube and ovary—the right—attached thereto. Two small fibroids were present, the larger on the dorsal surface and the smaller on the ventral, both attached well toward the fundus. The tube and ovary were bound down to the fundus of the uterus as shown in

FIG. 2

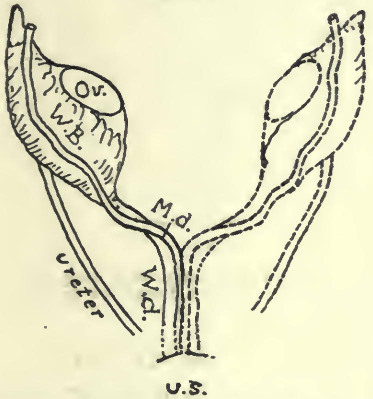


Two-thirds natural size, with sections 10-diameter magnification.

Fig. 1. Both were very much distended. The broad ligament on this side consisted of a contracted mass of adhesions. Numerous remains of adhesions were still attached to the organ, particularly where the fundus and tube had been attached to the liver, and at the lower portion, where attachments had connected it with the bladder. There was no evidence of ovary, tube, or broad ligament on the left side.

The specimen was opened longitudinally on the ventral surface, but well to the right of the median line. It was found to be tensely distended with blood—black, thick, and "tarry." The tube was filled with the same material as were also two or three cysts of the ovary, each of which seemed to be the remains of a much distended corpus luteum.

Fig. 3



Hypothetical embryological development, early stage. *Ov*, Ovary. *WB*, Wolffian body. *Wd*, Wolffian duct. *Md*, Mullerian duct. *Us*, Urogenital sinus. The dotted portions on the left side and at the lower end of the Müllerian and Wolffian ducts are those portions which are supposed to have remained undeveloped in the present case.

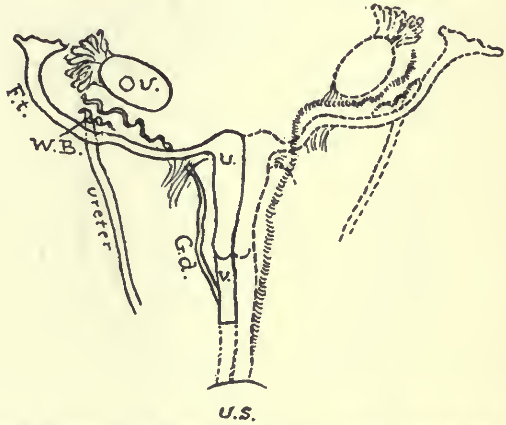
The lower porton of the tumor was more distended than the upper, and its walls were thinner and smoother. The upper half was fairly well marked off from the lower by an indefinite ridge, which suggested an imperfectly formed cervix.

Microscopic examination of the mucosa from the upper portion of the tumor (Fig. 2, *a, b*) proved that this portion was uterus with thick walls, lined with tubular mucosa, not very different from that in the normal uterus.

The lower and thinner walled portion showed, microscopically, mucosa (Fig. 2, *c, d*) with flattened epithelium, such as is found in the vagina normally. The walls of the vaginal portion, though thinner than those of the uterine portion, were still enormously thickened, when compared with normal vaginal walls. There was complete absence of the lower end of the vaginal portion.

The specimen would appear, therefore, to be the result of the development of the embryological elements of the right side only, with a destruction of the lower ends of these elements, resulting in a failure of the Müllerian and Wolffian ducts to unite with the urogenital sac. This hypothesis is further explained in the diagrams, Figs. 3 and 4, in which the parts represented by dotted lines are those which probably failed to develop. Such a hypothesis would account also for the absence of the left kidney and ureter. It is difficult to understand why there should have been a failure of the lower portions of the Müllerian and Wolffian ducts to develop, thus leaving the large space, probably 10 cm. between the closed end of the vagina and the perineum. Since the tumor was removed by the suprapubic route there was no opportunity to examine the intervening structures.

Fig. 4



Hypothetical embryological development, later stage. Parts correspond to those in Fig. 2, except remains of Wolffian duct are designated, *Gd*, Gaetner's duct: *U*, uterus; *V*, vagina.

PERI-URETERAL PELVIC PHLEBOLITHS.*

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In the Röntgen Congress of 1905 the nature of certain small shadows, varying in number and in size from a shot to larger than a pea, occurring in X-ray plates of the pelvis about the spine of the ischium and the horizontal ramus of the os pubis, was discussed without being definitely settled.[1]

A recent writer claims they occur so frequently that in his six hundred pelvic radiographs of persons over forty years of age, it is the exception not to find some of these shadows.[2]

Similar shadows have been variously explained as being due to artefacts,[5] areas of calcification in the pelvic ligaments,[3] ossifications in the muscles,[1] intestinal concretions and foreign bodies,[6] appendiceal concretions,[7] phleboliths, and many other things. Instances are recorded of diagnoses of ureteral calculus based on such radiograph shadows, but at operation no calculus was found.[4]

M. G. H., autopsy 2207 (September, 1908), furnished a specimen (Fig. 1) which, because of its unusual character, led the writer to a special study of phleboliths, their possible bearing on the above-mentioned question, and their relation to the differential diagnosis of ureteral calculus.

During the last few years, literary contributions to the subject have been many, frequently contradictory, and, I believe, in no single instance comprehensive. To any interested members of the profession who have not the time to sit in judgment on all previous contributions to the literature, and to any others who may doubt the reality of phleboliths or their

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* To Dr. F. A. Washburn, Resident Physician, M.G.H., to Drs. J. H. Wright and O. Richardson of the Laboratory of Pathology, to Dr. George B. Magrath, Medical Examiner of Suffolk County, and particularly to Dr. Walter J. Dodd, Radiographer, the writer is indebted for courtesy, material, and assistance.

ability to cast X-ray shadows, this existing state of confusion may serve the writer as an excuse for submitting this study of what at first sight might appear to be "much ado about nothing."

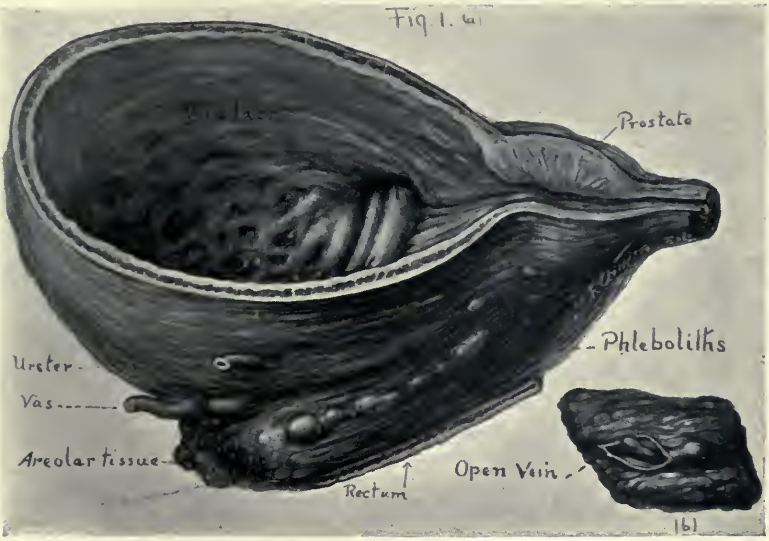
The writer's specimen consists of the male urinary bladder, ureters, prostate, seminal vesicles, rectum, and tissues immediately connected with the same, removed *en bloc* from a subject whose clinical history (M. G. H., 159,372) contains nothing worthy of note except, "Age, 78 years. Denies venereal disease. Osteomyelitis of left femur of some years duration. Recently, spontaneous fracture of same, necessitating amputation above the knee joint. Later, œdema of the lungs, death." Post mortem were found bronchopneumonia, arteriosclerosis, and the present specimen (Fig. 1).

The bladder is somewhat trabeculated, and, in the region of the trigone, shows evidence of a severe inflammatory process probably long since healed. The periprostatic or rectovesical venous plexus (abyrinthus venosus Santorini) shows bilaterally extensive thrombosis and within the vein lumen in different places eighteen phleboliths (Figs. 2 and 3), the heaviest separate veinstone weighing 150 mgm.

Though exact knowledge of the metamorphosis does not seem to be recorded, phleboliths are defined as having been originally white thrombi in veins which have subsequently undergone calcification,[10] analogous to arterioliths in arteries.[11] Examination of the present specimen accords with this view. In some parts of the plexus the veins are merely thrombosed, elsewhere the lumen is free. The thrombi exist in stages of metamorphosis varying from soft putty-like consistency to practically complete calcification. In other places the vein is represented merely by a string of fibrous tissue.

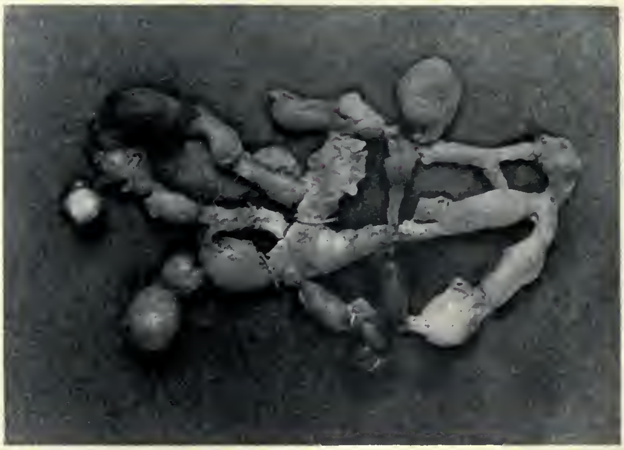
That portion of the thrombus actually calcified may be properly designated phlebolith,—it is of stony hardness, generally oval or round, but sometimes pear-shaped, of smooth but not always regular surface, yellowish white, and of variable size. Section reveals a grossly, homogeneous construction of alternating, more or less concentric strata enveloping

Fig. 1.



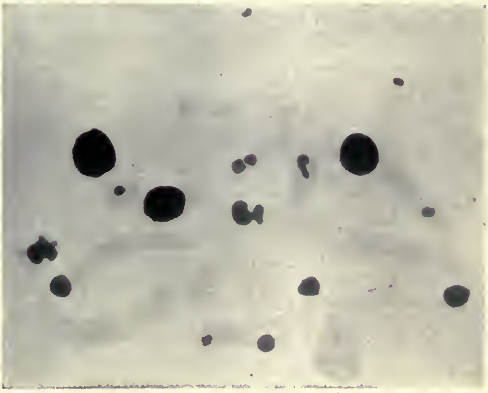
M.G.H., 159372.

Fig. 2.



Veins containing phleboliths and thrombi, from writer's specimen. Compare with Fig. 1 b. and Fig. 3.

Fig. 3.



Radiograph of Fig. 2. Note (1) relative atomic density of phleboliths and thrombi; (2) variation in size of phleboliths, in shape, outline, number, lamination. Compare radiographic appearance of phlebolith as actually existing (Fig. 3) with result of radiographing the same clinically (Figs. 4, 5, 6.), where lack of definition occurs.

a central kernel. Surrounding the phlebolith proper, and lightly in contact with or slightly adherent to the vein wall is an ever-present albuminous envelope representing not yet calcified thrombus. Where the vein stone is large this envelope is thin, tough, of yellowish-white color, easily peeled off the vein stone. Elsewhere, it varies in thickness, consistency, and color, so that it is sometimes more properly thrombus plus calcified centre, rather than phlebolith plus envelope.

It would seem that the process of calcification starts about a central nucleus or kernel and proceeds toward the periphery, since the size of the completed products varies from a millet seed upwards and since in no case can be found an outer calcareous shell enveloping an inner softer mass not yet calcified (see Fig. 3). On the contrary, all of the phleboliths have between their surface and the vein wall an albuminoid envelope not yet calcified. In no instance is a phlebolith found lying loose in the tissue, hence they are obviously of intravenous origin.

As late as 1908, a foreign radiographer of experience expressed doubt as to the actual existence of phleboliths, and wonders " why if these so-called phleboliths are responsible for the shadows so frequently met in pelvic radiography, they are not more common in the dissecting room." [2]

Reference to literature shows that the existence of phleboliths has been recognized by pathologists from an early date. They are recorded as having been found most " frequently " around the prostate and bladder in men,[10] in the plexus pampiniformis in women,[10] and in the spleen [14]; not uncommonly in the uterine veins,[5] sometimes in the saphenous veins; also in the mesentery.[6] Exact figures as to frequency of occurrence are wanting. That mention of such occurrence is not oftener made in post mortem records may be due to the pathologist's conviction as to their frequency and intrinsic harmlessness, and to his ignorance that a record of their existence or nonexistence could be of interest to any one. In fact, generally, he probably does not even search for them.

Perhaps this may partly account for the prevailing impression as to their rarity. Since the writer's attention has been directed to this question, he has during the last six months demonstrated the very frequent occurrence of phlebolith about the prostate of autopsied male adults. No instance is reported of phleboliths existing in childhood, nor of shadows in the pelvic radiographs of children attributable to phleboliths.[3]

In 1861, Balogh minutely described the microscopic and chemical examinations of a phlebolith weighing 120 mgm.—one of fourteen found at autopsy in the veins of the posterior bladder wall.[9] The mineral composition was found to be principally carbonates with a small amount of phosphates, calcium oxide, and traces of magnesium and iron oxide. Microscopically appeared corpora amylacea, blood corpuscles, and other cells in various stages of granular degeneration—all entangled in the meshes of coagulated albuminous matter representing the framework of the stony structure. In Balogh's patient malignant disease was the cause of death. This process he erroneously conjectured was the direct cause of the phlebolithic formation.

As to etiology, certainly the process of calcification is preceded by the existence of a nucleus,—in this instance a thrombus; but exactly what determines why one thrombus shall undergo resolution, another organization, and another calcification has not yet been conclusively proven. Pertinent factors predisposing to thrombosis are idiosyncrasy plus local venous circulation of a lowered or impaired degree, congestion, changes in the vessel walls from constitutional disease or from advancing age with its accompanying venous varicosities [16] and arteriosclerosis [18]; also phlebitis [15] and possibly inflammatory processes arising in neighboring structures.

The majority of such factors are conditions very frequently found in the adult pelvis and could account for the common occurrence of phleboliths in this region.

By appropriate bacteriologic technic, drill dust aseptically obtained from the cores of several sizes of vein-stones, separately tested, then planted in blood agar culture tubes and incubated for forty-eight hours resulted in neither a positive growth nor the discovery of any bacteria in the stained smears obtained from the tubes. As to a possible bacterial etiology of phleboliths, such a result is. unfortunately, of very slight value and only negative at that.

Reports of positive symptoms during life caused by phleboliths *per se* the writer has not found. In fact, it is difficult to believe that such an innocent end-product of thrombosis could in itself cause venous obstruction, ulceration of the vein wall, or even appreciable pressure on a neighboring nerve with consequent irritation.

Nevertheless, these pelvic phleboliths are of very real importance from the chance they afford when present of being mistaken for something else of clinical concern. An intimate acquaintance with their characteristics will be of aid to both surgeon and radiographer, particularly in the interpretation of pelvic radiographs where the question of ureteral calculus arises; for of 30 subjects radiographed post mortem, Mr. Fenwick's radiographer found 8 that showed concretions in the pelvis other than ureteric calculi. In 7 phleboliths were present.[8]

In rectal and vaginal examinations a knowledge of their existence may help to explain some of the indefinite nodules sometimes entering consideration in the differential diagnosis of ureteral calculus, concretions in the bladder, in the prostate, in the seminal vesicles, in the lymph-glands, in peritoneal tuberculosis, other local tuberculosis, and possibly cancer.

In the course of a prostatectomy, either suprapubic or perineal, should some of these phleboliths be encountered, an attempt to worry them out of their vein sheaths could result in no good and would very likely increase hemorrhage.

To ascertain facts as to the actual appearance in a radiograph of phleboliths, the following experiment was done. A male cadaver was obtained and from it removed everything which might be expected to cast a shadow representing any sort of substance not anatomically a normal portion of the bony pelvis. In proper anatomical position was then anchored *en bloc* the specimen of bladder, prostate, rectum, seminal vesicles, phleboliths undisturbed as they existed in the vesicoprostatic plexus, and the ureters, each containing a fine metal probe. The pelvis of this cadaver so prepared, and the abdominal incision closed, was then radiographed as if it were a living patient suspected of having ureteral calculus (Figs. 4, 5 and 6).

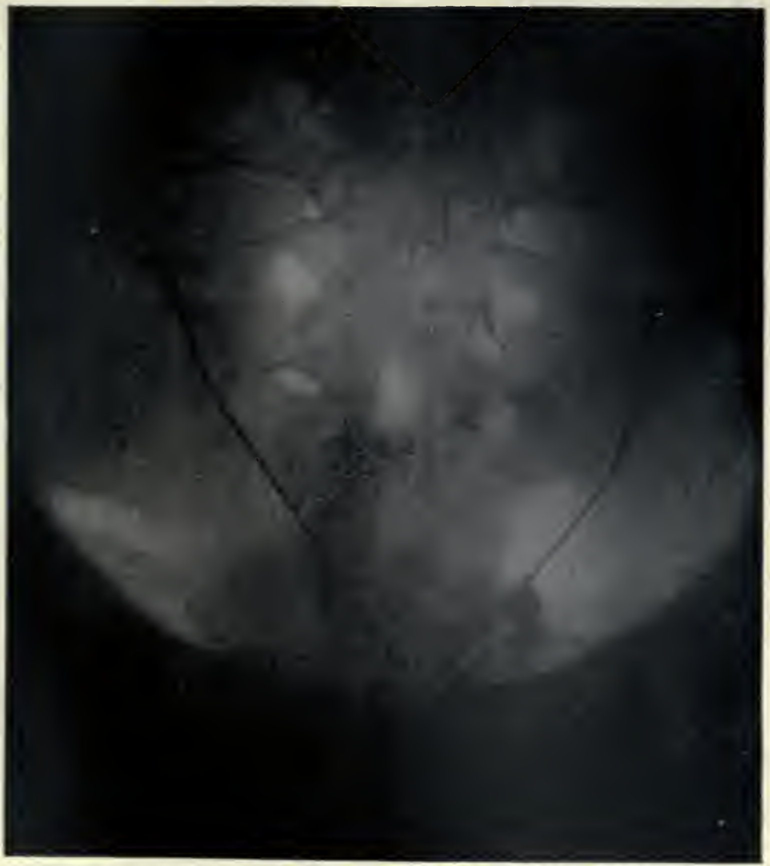
It proved conclusively that: (1) Experimentally, a phlebolith may cast a shadow in an X-ray plate; (2) Conversely, that clinically, shadows seen in a pelvic radiograph may be caused by the presence in the patient of phleboliths.

Further is to be observed that: (1) The area of their distribution may embrace the pelvic course of the ureters; (2) The number may vary—they are characteristically multiple and bilateral; (3) Where multiplicity occurs, lines drawn on the plate connecting the shadows are apt to give a line at variance with the course of the ureter; (4) The size of the shadows varies from minute to as large as what could cause ureteral obstruction if situated within the ureter (see Fig. 3); (5) Their outline in the clinical radiograph is generally regular and their density even, contrasting with the less definite and generally irregular or angular outline of a true calculus shadow. (The concentric lamination markings of the vein stones as seen in Figure 3 are lost in the clinical radiograph and the appearance of the shadows suggests the comparatively homogeneous chemical consistency of the vein stones (see Fig. 4, 5, 6), in contrast to the frequently varying composition of urinary stones, where the component salts vary and present corresponding variations in the shadow because of the different degrees of atomic density.)

Where, in addition to, or in place of employing Kelly's wax-tipped ureteral bougie, the X-ray is used to further diagnosis, even then casually to diagnose as ureteral calculus a shadow seen in a pelvic radiograph is obviously to invite possible disappointment,[8] as instances of fruitless operations based on such diagnoses are recorded.[4, 5]

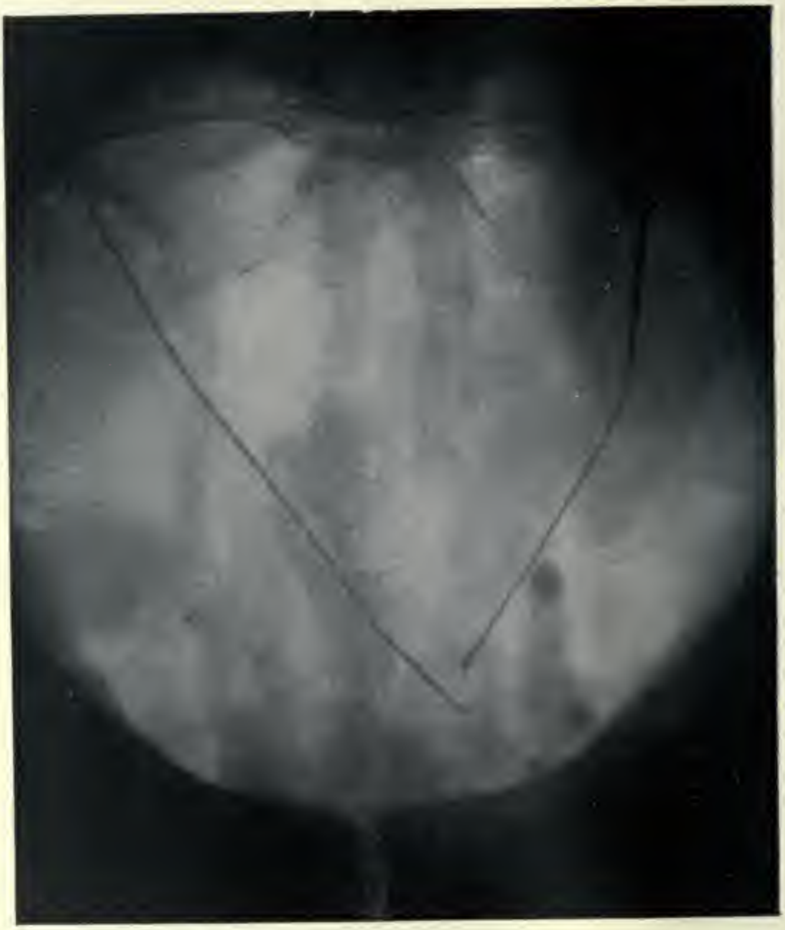
To state positively the cause of a given radiographic

Fig. 4.



Phlebolith and ureteral indicator fall in the same anteroposterior plane. Compare with Fig. 5.

Fig. 5.



By shifting the X-ray tube the "suspicious" shadow appearing in Fig. 4 is shown to be extra-ureteral.

Fig. 6.

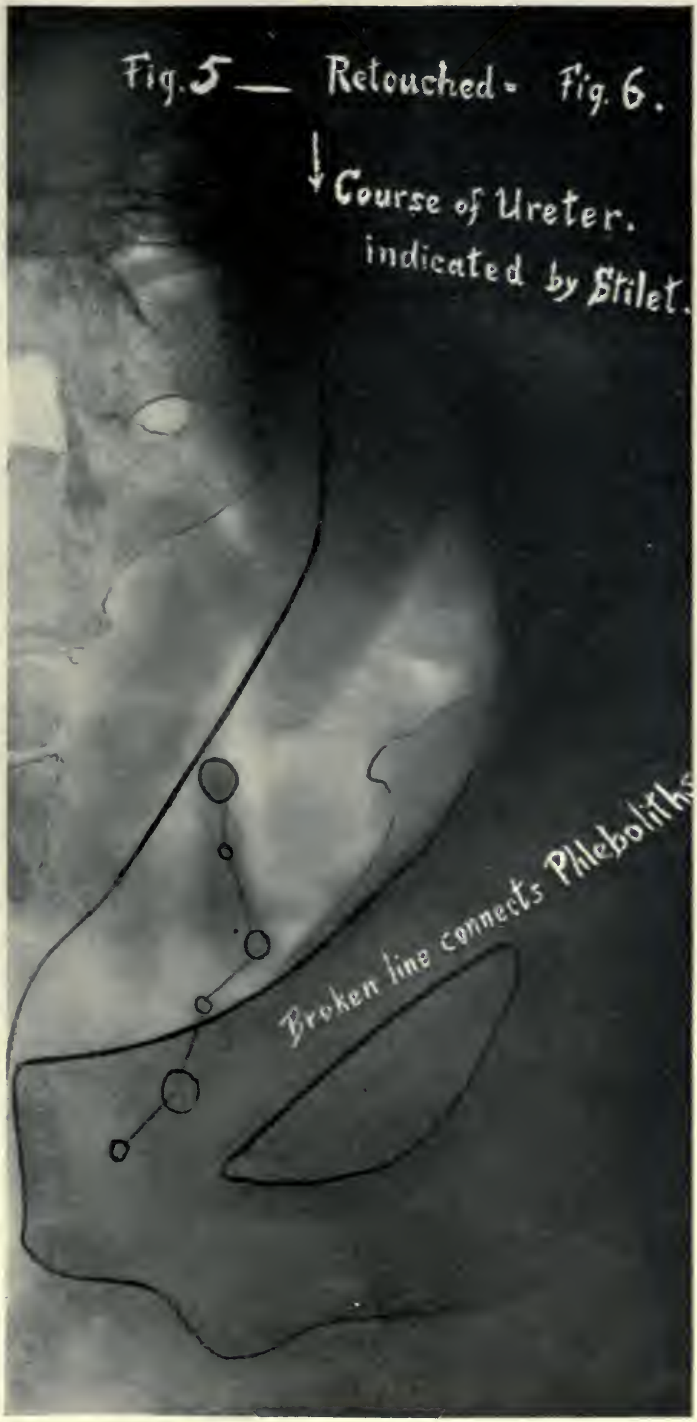


Fig. 5 — Retouched = Fig. 6.
Course of Ureter. indicated by Stilet.
Broken line connects Phleboliths

shadow may be very difficult in many cases. Practically, what we primarily seek definitely to establish as regards radiography in a case of suspected ureteral calculus is whether a given shadow is of intra-ureteral origin, or extra-ureteral,—in the latter instance due to any one of many possible causes in themselves perhaps of only academic interest.

Kolischer and Schmidt[17] devised bougies bearing metal cores for insertion in the ureters previous to radiography. Their experiments on the cadaver showed the feasibility of applying this method clinically to ascertain the relationship between a suspicious shadow and the ureteral course as indicated in the radiograph.

Reichman[18] reports the case of a patient suffering from unilateral colic clinically indistinguishable from the ureteral variety. The X-ray plate showed a corresponding shadow, and operation was advised. A radiograph taken after introducing ureteral stiletted bougies showed the suspected shadow to lie 2 cm. outside the ureter's course.

In spite of this technic, it is possible to be misled in case the suspected shadow and that of the bougie lie in the same anteroposterior plane (see Fig. 4). Albers-Schönberg has called attention to this fact and showed a radiographic illustration. In his case the suspected shadow was in reality due to a concretion in the uterine plexus 6 cm. away from the ureter.[1]

To demonstrate the relationship of bougie and suspected shadow in such instances, it has been suggested that the patient or the lamp be shifted to vary the path along which the rays travel through the suspected object to the plate.[3] Stereoscopic radiography has been employed.[8] The effects of shifting the light are seen in Figures 4 and 5.

Caldwell states stereoscopic X-ray plates have proven of little value unless the course of the ureters is outlined by the shadow of the ureteral catheter.[19] With such technic he has demonstrated ureteral calculus to be in contact with the ureteral bougie.

The procedure of introducing ureteral bougies is not without its own peculiar risk. This risk naturally varies depending on the conditions existing in the patient as well as on the special qualifications of the operator. From the writings of Albarran, Israel, Casper[20] and others,[21] the writer believes that this procedure as employed by experts is attended by no appreciable risk either transitory or lasting. For the technic of ureteral catheterization or bougieing—the indications and contra-indications—the reader is referred to the extensive bibliography chronologically arranged by Ricketts.[22]

Summary.—1. Phleboliths have been recognized by pathologists for centuries as realities.

2. They occur frequently in the periprostatic veins of men and in the plexus pampiniformis of women, varying in size and number.

3. Symptomless in life, and requiring no treatment, they may be discovered only post mortem or in the course of rectal, vaginal, or radiographic examination.

4. In pelvic radiographs they cast small shadows about the spine of the ischium and horizontal ramus of the os pubis, frequently in the course of the pelvic ureter. (*a*) Characteristically, these shadows are multiple and bilateral, but the number and site may vary. (*b*) Frequently the size of birdshot, they may be as large as what could cause ureteral obstruction if intra-ureteral. (*c*) Shape, generally round or oval, may be slightly irregular. (*d*) Density, in contrast to usual ureteral calculus shadows, evenly rendered. (*e*) Where multiple, lines connecting the shadows may show an axis at variance with the ureter's course (Fig. 6).

5. Familiarity with these characteristics will enable the interpreter of a pelvic radiograph to identify, in most cases, certain shadows as being cast by phleboliths.

6. In other cases they may so obscure diagnosis of ureteral calculus that before facts are definitely ascertained it will be necessary to resort to repeated X-ray exposures, varying the relative positions of light, patient, and plate; ureteral bougieing previous to radiography, possibly to stereoscopic X-raying with bougies *in situ.*

7. Suitable technic exists to make certain, without undue

risk, in practically all patients suspected of having calculus in the pelvic ureter the intra-ureteral existence or nonexistence of the substance causing a given shadow.

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CYST OF THE PROSTATIC URETHRA.

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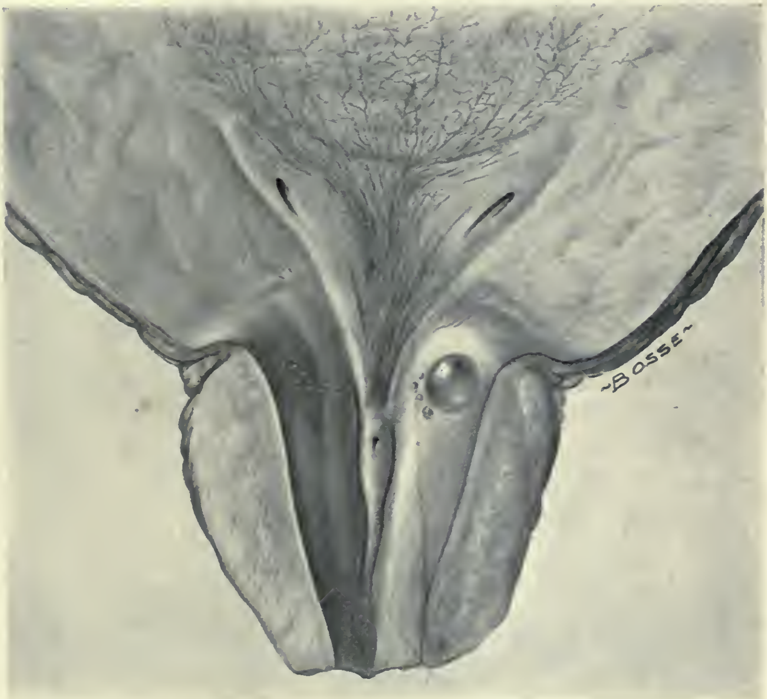
In the course of a histological and anatomical study of the posterior urethra, we recently encountered a specimen of prostatic cyst, or cyst of the prostatic urethra, which, because of its rarity, deserves a short mention. It was found at autopsy in a man, 38 years of age, who had died of peritonitis.

Situated about 8 millimeters below the margin of the internal sphincter, on the left side and at the junction of the anterosuperior with the posteroinferior urethral wall, we found a tense cystic body, projecting into the lumen of the urethra. Its hemispherical surface was formed by extremely thin glistening mucous membrane, which by virtue of the color of the fluid content gave a greenish yellow sheen. The cyst measured about 6 millimeters in diameter, its highest point being elevated about one-half a centimeter above the level of the surrounding mucosa. Just medial to it, a few tiny pinhead-sized glistening points indicated the presence of similar but much smaller fluid collections. At a corresponding site on the right side there were the beginnings of minute cyst formations. None of these lesions were placed in the region of the openings of the prostatic ducts, but a fair distance above (cephalad) and to the outer side of these.

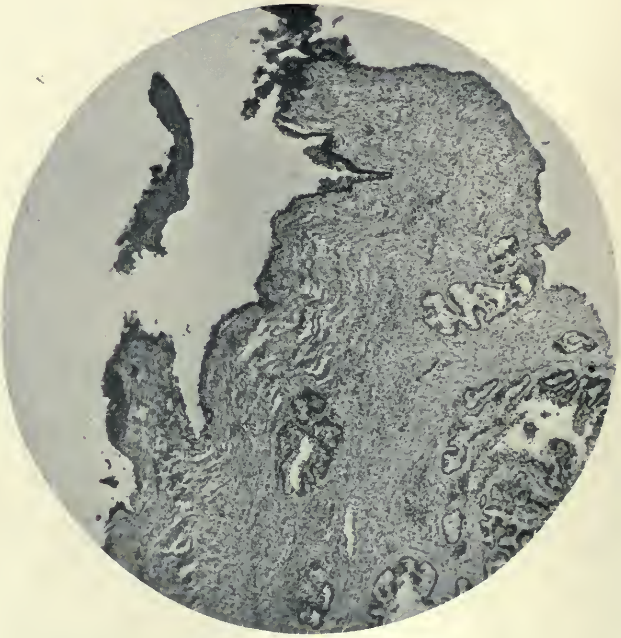
Upon opening the thinned wall of the cyst, thick, mucoid, green-yellow fluid escaped. A close inspection of the cavity thus exposed revealed the fact that the intraprostatic extent was far less than was indicated by the intra-urethral protrusion, the cyst having developed towards the mucosa rather than into the denser connective and muscular tissues of the prostate. The fluid was found to contain a very few cellular elements in the shape of desquamated, degenerated epithelial cells, and some granular detritus. There were no corpora amylacea.

FIG. 1.



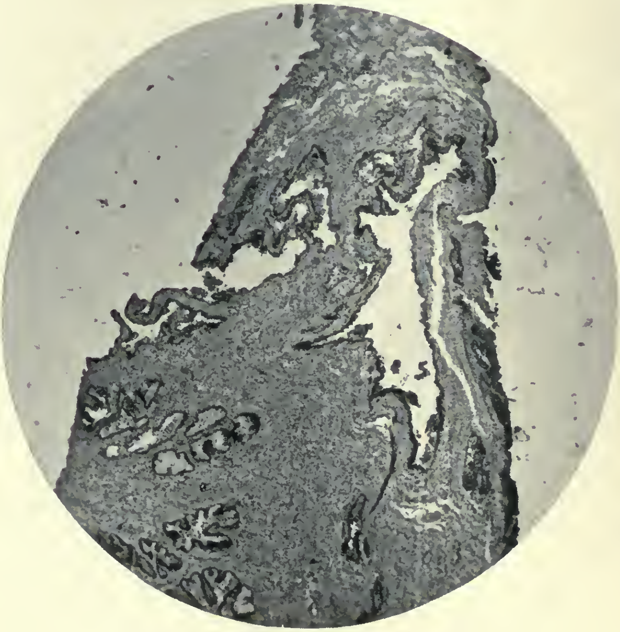
Prostatic urethra opened anteriorly, exposing the large cyst near the vesical sphincter.

FIG. 2.



The irregular bay in the upper left-hand part of the photograph represents a portion of the deep wall of the large cyst.

FIG. 3.



Section showing one of the smaller cysts.

In Fig. 2* a small portion of the opened and very much shrunken prostatic wall of the cyst is shown. It is lined by two to three layers of compressed epithelium, and has apparently had its beginning in the subepithelial layers of the prostatic urethra. Its growth into the prostate is very slight, and its extension has occurred mainly in directions parallel with the mucous membrane, the central portion of which has been lifted up in the lenticular manner depicted in Fig. 1. The intraprostatic portions of one of the smaller cysts is to be seen in Fig. 3.

A review of the literature bearing on this subject has convinced us that in our specimen the location of the cyst is unique. Although Morgagni had already mentioned the occurrence of cysts in the prostate, these must be rather uncommon, for, excepting those that are the results of retention in the hypertrophic organ, very few cases with accurate pathological descriptions have been recorded. Englisch found that closure of the orifice leading into the sinus pocularis not infrequently gives rise to retention cysts in the new-born, that micturition may be prevented by obstruction to the vesical outlet, but that spontaneous cure usually takes place on the second or third day of life, by reason of the rupture of the cyst. Springer has reported that this lesion of the utriculus is found in the adult and he describes three such cases and a fourth in a boy of one year and nine months old.

A rarer site is the *pars supramontana.* Englisch saw a hemispherical tumor about 1½ centimetres in diameter just at the middle of the posterior half of the internal sphincter, and attributes its formation to dilatation of aberrant prostatic glands. Socin and Burckhardt were able to diagnosticate a similar tumor with the cystoscope, and removed it successfully. They also record the finding of a cyst of the prostatic urethra at autopsy of a man, 59 years of age who never had any urinary symptoms. The tumor is said to have been situated on the right side of the posterior wall of the vesical neck, was about the size of a pea, and contained clear serous fluid.

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* The photomicrographs were prepared by Dr. F. S. Mandlebaum, director of the Mount Sinai Pathological Laboratory.

In our case we are dealing with a small retention cyst evidently arising from glands of the prostatic urethra in a part of the canal that is normally sparsely supplied with glandular elements. The dilatation in the immediate vicinity of the larger cyst, and the similar changes on the opposed wall, point to the existence of glands that may be regarded either as abnormal prostatic or enlarged glands of the urethral mucosa.

It is unfortunate that we were unable to obtain data that might have enlightened us as to whether the lesion had caused any symptoms. Nevertheless, it is clinically of interest to note the possibility of the presence of such cysts, and to theorize as to the manifestations that these could produce either by rupture or by interference with the normal action of the vesical sphincter.

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INTERILIO-ABDOMINAL AMPUTATION.

WITH REPORT OF A CASE.

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MY reasons for presenting this paper are that the case report which gives it foundation is the third of its kind to be recorded in the United States, and I feel justified in counting it among the operative successes. Had Billroth's interilio-abdominal amputation performed in 1891 been a success, it is quite certain that it would not have remained unknown for eleven years, to be recorded finally on verbal testimony alone. If a name is to be attached to the operation it should be that of Jaboulay of Lyons, who in three years had three opportunities of performing it. He reported no successful operation, and only one of his cases survived the fourth day.

The case which I beg to report is the following.

James F., colored, æt. 45. Was admitted to the Cincinnati Hospital September 29, 1908. The family history is negative. There is a history of an initial lesion twenty years ago, and of repeated attacks of gonorrhœa. Six years ago the patient was kicked in the right hip by a mule. Three years later he noticed a swelling in the right groin, which, gradually increasing in size, caused a swelling of the foot and leg. He entered the hospital the first time February 18, 1908, for this swelling in the groin.

Examination on admission showed the patient to be normal, save for the inguinal swelling and the œdema of the leg. The swelling in the inguinal region was the size of two fists, very hard and attached to the ilium. The tumor was painless. The femoral vessels were displaced forwards. On the inner side there were several distinct and isolated inguinal glands about the size of a pigeon egg. Hip movements at this time were not impaired except in abduction. The entire extremity was œdematous.

On February 24, 1908, the bony tumor was removed by Dr. E. W. Walker. The laboratory report showed the tumor to consist of cancellous bone with no evidence of malignancy, but a slight round-celled inflammatory infiltration into a portion of it. Recovery from this operation was seemingly complete. The result was good and the patient left the house May 2, 1908; has been at work at common labor until two weeks ago, September 12, 1908, when an abscess in the region of the former tumor ruptured. The discharge has been very free ever since.

Status Præsens: September 29, 1908. Head, neck, chest, and abdominal examinations negative. The right leg much larger than normal, from œdema. Little or no motion in the hip joint. Bony proliferations are felt on the right pelvis and the upper part of the shaft of the femur, and about the trochanter. There is a fluctuating painless mass on the inner side of the ankle. A sinus at the site of the former operation leads to exposed bone. It radiates in various directions. Pus channels have been formed all along the anterior part of the thigh. The general condition of the patient is not good; his appetite is poor, the pulse rate is fast and there are irregular elevations of temperature. The patient is septic.

On October 5, 1908, a long incision was made on the front of the thigh for drainage, and a large piece of necrotic bone removed. From this time on the wounds were irrigated two or three times a day and packed with gauze. From time to time the local treatment varied, iodoform and bismuth injections being used. The patient's condition failed to improve, the discharge continuing very free and foul.

X-rays taken of the patient show a tumor the size of a fist, involving the iliac bone, the upper end of the femur and the tuberosity of the ischium.

December 28, 1908. The wound was enlarged under local anæsthesia and curetted for better drainage. Before this was done, an amputation was highly recommended to the patient, but he refused. From this time forth a typical septic course continued.

From day to day the evening temperature rose from one and a half to three degrees; the pulse fluctuated between 90 and 110; night sweats were frequent and the patient was bedridden. From a number of sinuses on the anterior and outer portions of the thigh and gluteal regions large quantities of pus were being discharged, notwithstanding the use of frequent irrigations. It was in this condition that as a last resort an interilio-abdominal amputation was done.

Operation, March 8, 1909. Ether anæsthesia. Esmarch bandage applied to the entire leg to preserve its blood for the patient. The right common iliac artery was next tied through a median abdominal incision. On account of the numerous sinuses in the region of the trochanter and over the gluteal mass, it was possible only to make use of an internal flap. The first incision was made a little below the crest of the ilium and Poupart's ligament, from the posterior superior iliac spine to the centre of the ligament. The incision was continued through the various layers of soft parts until the fascia transversalis was reached. In doing this a number of sinuses with exceedingly indurated walls and dense cicatricial tissue were cut through. Nevertheless, the fascia and underlying peritoneum were reflected without opening the abdominal cavity until the brim of the true pelvis was exposed for nearly its entire length on the side affected. The next step of the operation consisted of making the long internal flap, the incision beginning at the centre of Poupart's ligament and coursing down the anterior surface of the thigh and terminating with a long curve in the posterior incision which terminated above at the point of starting. This long internal flap was quickly dissected from the surface of the femur with very little bleeding. With a very broad chisel the iliac bone was next divided in front of the sacro-iliac joint, the cut being rapidly made from the crest to the sciatic notch. An inch to the outer side of the symphysis the chisel was next applied and driven to the thyroid foramen. It was similarly used to cut through between the ischium and pubes. I am sure that the use of the chisel greatly shortened the time of the operation. On the other hand, the forceful blows necessary to cut through the bone were associated with shock, as evidenced by the rapid fall of blood pressure. At this time an intravenous transfusion of normal salt solution, for which preparation had been made, was given. The removal of the lower extremity with the resected part of the iliac bone in one piece was then very quickly accomplished with a few strokes of the knife. During the operation the patient did not loose more than a few ounces of blood, and most of this, strange as it may seem, came from the femoral artery when it was divided. Doubtless the anastomotic circulation with the other side had been very free. I have recently seen the same free bleeding from a divided femoral artery immediately after the common iliac was tied. We encountered no enlarged glands in the operation. The wound was closed with buried muscular sutures and ample drainage for the many and irregular sinuses and thick walled pus cavities encountered in the course of the operation. The patient left the operating table in very fair condition.

The subsequent history was that of a continuous and unequal struggle with the sepsis present before the operation. As has occurred so often where the long internal flap was used, gangrene of the wound margins developed in two or three days and necessitated removal of many of the sutures. The repair power of the patient was at a minimum. The use of streptolytic serum especially prepared failed to make any impression on the septic condition. An enterocolitis, septic in character, developed four weeks after the operation and could not be controlled.

The autopsy revealed caseating pulmonary tuberculosis, acute toxic nephritis, myocardial degeneration, and advanced fatty degeneration of the liver. The clot in the common femoral was well organized. The wound in the peritoneum over the artery where it was tied could scarcely be found.

An examination of the specimen which I beg to present and of which I submit X-ray plates, showed it to be, in my judgment, an osteosarcoma (Fig. 1).

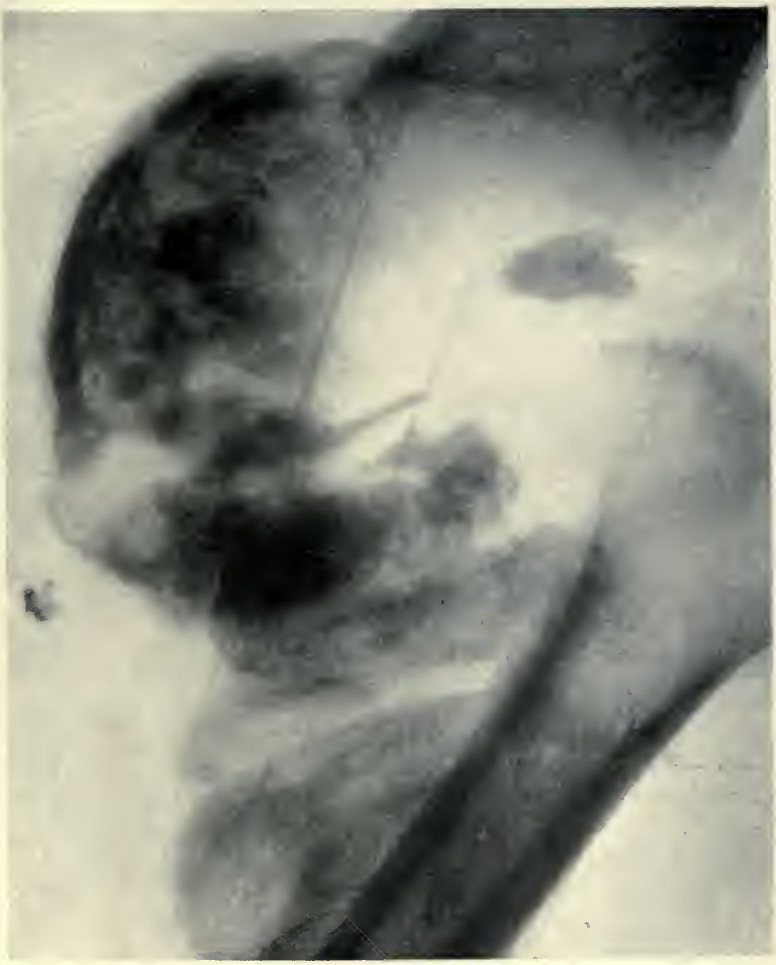
The following is the report of Dr. Marion Whitacre.

Specimen presented for examination consisted of upper end of femur, the hip joint and a part of the pelvis.

After removing the soft parts, the tumor mass seemed to be very hard, not bony hard, as the surface seemed to be made up of a dense tissue almost of a cartilaginous tissue. There were sinuses extending into the growth at various places from which a purulent fluid ran when the packing was removed.

Small pieces were taken from various parts of the growth in the soft parts above mentioned for microscopic examination, the report of which will follow. The tumor mass was then sawed in two, the endeavor being to pass through the head of the bone and at same time get a good view of the tumor growth. Small pieces of bone were taken at different places for examination.

FIG. 1.



X-ray plate. Osteosarcoma of pelvis.

The specimen gave the appearance of being a hard osteoma surrounded by a large amount of chronic inflammatory matter.

MICROSCOPIC EXAMINATION.—The sections of the hard fibrous tissue were made up of a large amount of dense connective tissue with considerable evidence of degeneration in places. Other places showed a rather vascular condition with considerable evidence of acute inflammation in the presence of leukocytes throughout the tissues. At one or two places the sections showed distinct evidence of sarcomatous growth in the presence of large number of round and spindle cells. The blood-vessel walls were very poorly formed, many of them being made up of the cells of the tumor. There was also evidence of capillary hemorrhage in places.

The bony section after decalcification showed for the most part a hard cancellous bony growth, but on one side showed evidence of the invasion of the sarcomatous elements. The trabeculæ of the bone were invaded by a connective tissue growth, which were of the spindle shape.

From the examination, I should be inclined to think that the growth was originally an osteoma surrounded by a considerable area of inflammatory tissue, and that the mass on one side had undergone a malignant change and this had also invaded the bone, thus giving the diagnosis of osteosarcoma.

The indications for interilio-abdominal amputation have thus far been neoplasms of the upper end of the femur and of the pelvis and intractable tuberculous coxitis involving the acetabulum and iliac pan. In regard to prognosis these cases should be separately classed according to the nature of the disease, whether tumor or tuberculosis. A further division should be made between the operation done in one stage and those in which after a varying interval the amputation at the hip is followed by a more or less extensive resection of the innominate bone. I have endeavored in the following tables to record all of the operations hitherto published. Of the total number, thirty-four cases, nineteen were tabulated by Keen and Dacosta in 1904.

TABLES.

It will be seen from Table No. 1 that the postoperative mortality of this amputation "the most extensive operation in all the realm of surgery," is 68 per cent., counting the cases of death after twenty days with the operative recoveries. In this I have followed the lead of Keen. In the cases where the resection of the pelvis was preceded by amputation at the hip, no deaths followed the second operation. From this it might be inferred that this course is preferable as a routine procedure. Unfortunately, in tumors of the pelvis, the two-stage operation is not feasible, and in those for tuberculosis none other is ordinarily applicable. In the case recorded by Freeman, the amputation at the hip was immediately followed by resection of the pelvis. The extent of the disease was evidently not apparent until the hip-joint amputation had been done. In the cases of Girard and Pringle the second operations were made for recurrent disease after disarticulation at the hip.

Doleful as are the immediate results of interilio-abdominal amputation, the end results have been even more unpromising. The cases of Girard classed with recoveries, died within six months of recurrence. Pringle's case died in five months with metastases. Salistcheff's case was reported well within four months of the operation. The end result I do not know. The record case is probably that of Freeman. Although he left the anterior third of the acetabulum and of the ilium, the case belongs in the category of interileo-abdominal amputation. Freeman's case was well at the end of sixteen months when reported, but died twenty months after operation from recurrence in the abdominal wall (personal communication). Of the end results of the operation for tuberculosis, the data are extremely meagre. The case of Bardenheuer gained in health and strength four months after the operation, and it is presumed was a permanent recovery. The case of Pringle was without recurrence seven years after the operation.

In the face of these unpromising results, it may be questioned whether the operation is justified. The same question has been put for every major operation in surgery, and has in the course of time with unvarying uniformity been answered affirmatively. By limiting the operation to suitable cases and performing it at a time when there is at least a probability that the patient can bear the shock connected therewith, it is almost certain that the prognosis will improve as it has so markedly for amputation at the hip. Disseminating the knowledge that the operation is feasible will, by bringing the cases earlier to the surgeon, contribute much towards this desirable end. With two exceptions, I know of no text-book in which the operation is even mentioned.

In an operation of such magnitude, the initial mortality is largely due to hemorrhage and to shock. Of all the cases that are not included under postoperative recoveries, only two survived the fourth day. The prevention of hemorrhage has in most of the cases been sought by preliminary tying of the common iliac, the internal iliac or the external iliac. Many believe that the tying of the corresponding veins ought always be practiced. Kocher and Kadjan encountered severe venous bleeding. Tying of the thin-walled large veins doubtless would increase the difficulties of the operation. Faure, after a median laparotomy, applied a temporary ligature to the aorta just below the common iliac. Nevertheless, a severe venous hemorrhage from subcutaneous and subperitoneal veins necessitated abandonment of the operation. Nanu, Jaboulay, Cacciopoli, and Salistcheff also ligated the common iliac. Bardenheuer tied both the external and the internal iliac vessels. Freeman tied the external iliac and, later in the operation, the common iliac. Keen tied the internal iliac artery. That by the tying of the common iliac artery preventive hæmostasis can be accomplished, has been amply demonstrated in the case reported, and it was most satisfactory. Unfortunately where a long internal flap is, as in our case, a matter of necessity, there is great danger of gangrene. This had already commenced in Keen's case, although the patient lived only thirty-three hours. The gangrene strangely developed in the superior flap and not in the margin of the long internal. In my case the gangrene involved the long flap only. Were a similar case to come under my observation, I would tie the external iliac and the posterior trunk of the internal. In that manner the obturator artery would be left intact for the nutrition of the long internal flap.

What promises to be a decided addition to our methods of preventive hæmostasis is the method of Momburg. He encircles the abdomen below the costal border with three or four turns of a tourniquet, thereby controlling the circulation through the aorta itself. It seems that in the cases thus far cared for in this manner no harm has come to the viscera. It would seem, however, that the placing of the strap in such close proximity to the wound margin might make one feel that it would slip after the amputation is completed. This objection, it must be confessed, is a theoretical one on my part. It has been answered by a successful operation done by Bier, where the strap was kept in place for eighteen minutes.

The prevention of shock is a further desideratum. In our case there was no manifestation of shock until the chisel was used. While the use of the chain or wire saw may minimize this shock, it cannot in this way be entirely overcome. In a future case I should attempt the operation under spinal anæsthesia, which method was used by both Bier and Pringle with success. At all events, I should use the lumbar anæsthesia in conjunction with the general.

In regard to the amputation proper, there comes the question as to the extent of the pelvic bone to be removed. In the earlier cases the entire innominate bone from synchondrosis to symphysis was removed. One should be guided in this matter by the extent and site of the disease for which the operation is performed. Most of the primary tumors of the innominata spring from the iliac pan or the tuberosity of the ischium. Where it is possible, the ramus of the pubes and of the ischium should be left, since they give attachment to the rectus muscle and the corpus cavernosum. The likelihood of a hernia would be lessened.

In regard to the method of operating, writers differ. Where it is possible, a disarticulation at the hip may with advantage, as was done by Bardenheuer and Freeman, immediately precede the resection of the pelvis. A glance at the X-ray plate of the specimen removed in my case, shows that this procedure would have been unfeasible. This is true probably of the majority of cases of sarcoma springing from the pelvis. In this regard, as in that of securing adequate flaps for covering the extensive wound, every case must be considered on its own merits. This is doubtless the reason why so many methods have been devised for the interilio-abdominal amputation.

The original operation of Jaboulay consisted of making one large posterior flap. The first incision was made from the symphysis parallel to and over Poupart's ligament and the entire length of the iliac crest. By retracting the upper wound margins the soft parts are lifted from the iliac fossa and the vessels easily reached for tying. A circular incision is next made at the upper third of the thigh, through the centre of which on the anterior surface the two incisions diverge towards the pubes and the iliac crest. Thus a very large posterior flap is left which completely and easily covers the wound.

Girard operated in three cases by making internal and posterior flaps. Bardenheuer formed external and internal flaps, and Salistcheff in his successful case operated by the racquet method. He begins his incision below the twelfth rib and passes over the anterior superior spine of the ilium to Poupart's ligament, which it follows to the pubes. Through this incision the vessels are secured. The wide end of the racquet incision sweeps over the internal surface and back of the thigh and over the buttock to the point of starting. The simplest method, from an operative standpoint, is that of the long internal flap, the method of Savariaud slightly modified by Keen and adopted by me. It has the signal disadvantage of having to be exceedingly long to cover the wound. The risks of gangrene I believe to be larger after this operation than after any other. Where it is feasible, it appears to me that the incision of Salistcheff has superior advantages.

Interilio-abdominal amputation must always remain a desperate operation. It should never be resorted to where a less mutilating procedure is possible. Partial resection of the os innominatum for tumors of the iliac pan ought to be performed in preference to the interilio-abdominal amputation. Strange as it may seem, the three complete hemipelvic resections performed by Kocher (2) and Roux (1) all recovered. Whereas according to Croisier, of the partial resections there were eight deaths and seven operative recoveries. It is needless to add that these conservative operations have a place only for limited neoplasms. So far as the usefulness of the ilium is concerned in hemiresection of the pelvis, there has been less impairment of stability and usefulness than one might imagine. In the cases of interilio amputation that have survived, there has been no tendency towards eventration, a condition which one would judge to be a certainty after removing so much of the bony support of the abdominal viscera.

TABLE I.—OPERATIONS IN ONE STAGE FOR SARCOMA.

1. Billroth (1891). Death in a few hours. Verbal communication, Savariaud, Rev. de Chir., vol. xxvi, p. 350.
2. Jaboulay (1894). Death in 36 hours. Lyon Méd., 1894, p. 507.
3. Jaboulay (1895). Death in 24 hours. Province Méd., 1896 (Pringle).
4. Jaboulay (1895). Death in 5 days. Girard, verbal communication (Pringle).
5. Cacciopoli (1894). Death in 3 hours. Cent. f. Chir. (quoted), 1894, p. 988.
6. Gayet (1895). Death in 1 hour. Province Méd., 1894, No. xxxv.
7. Girard (1895). Recovery. Congrès Chirurg., 1898.
8. Faure (1899). Operation abandoned. Savariaud, Rev. de Chir., vol. xxvi, p. 365.
9. Freeman (1899). Recovery. ANNALS OF SURGERY, vol. xxxiii, p. 318.
10. Nanu (1900). Recovered from operation; gangrene of other leg. Congrès Internat., Paris, 1900.
11. Salistcheff (1900). Recovery. Archiv. f. klin. Chir., vol. lx, p. 57.
12. Savariaud (1901). Death in 2 hours. Rev. de Chir., vol. xxvi, p. 360.
13. Gallat (1901). Death in 1 hour. Annal. de Chir. (Belge), vol. ix, p. 569.
14. Morestin (1902). Death in 9 hours. Bulletin Arch. Gen., 1903, vol. cxii, p. 1665.
15. DeRuyter (1902). Death in an hour. Henri Myer, Inaug. Thesis, Leipzig, 1902.
16. Keen and DaCosta (1903). Death in 33 hours. Internat. Clinics, vol. iv, Series 13.
17. Kadjan (1903). Death on 2nd day. Yahresbericht f. Chir., 1902, p. 1104.
18. Kocher (1903). Death on 2nd day. Yahresbericht f. Chir., 902, p. 603.

19. Lastaria (1907). Died on table. Reforma Med., Napoli, vol. v, p. 457.
20. Orlow (1901). Lived 35 days. Yahresbericht f. Chir., 1902, p. 1104.
21. Bier (1908).* Recovery. Momburg, Centblt. f. Chir., 1908, p. 657.
22. Ransohoff (1909). Recovery. Lived 38 days.

* In a personal communication Professor Bier informs me that his patient died two months after operation, of recurrence in the abdominal wall.

TABLE II.—OPERATIONS IN TWO STAGES FOR SARCOMA.

1. Girard (1895). Amputation at hip. Some months later resection of pelvis. Recovery. Rev. de Chir., vol. xxvi, p. 365.
2. Pringle (1908). Amputation at hip. Death 6 months after resection of os innominatum. Lancet, Feb. 20, 1909.

TABLE III.—AMPUTATIONS FOR TUBERCULOSIS.*

1. Girard (1895). Died in 50 minutes. Rev. de Chir., 1898, p. 1141.
2. Bardenheuer (1897). Recovery. Gesellsch. d. Chir., xxvi, l, p. 130.
3. Gallet (1900). Died in six hours. Gesellsch. d. Chir., xxvi, 1, p. 130.
4. Ribera (Madrid) (1902). Died, collapse. Luis y Simon, Siglo Med., 1903, vol. v.
5. Ribera (1902). Died 8th day. Luis y Simon, Siglo Med., 1903, vol. v.
6. Ribera (1902). Died, collapse. Luis y Simon, Siglo Med., 1903, vol. v.
7. H. Vermeuil (1905). Died in 2 hours. Jour. de Chir. (Belge), vol. v, p. 406.
8. Morestin (1908). Recovery. Bull. Soc. de Chir., Paris, vol. xxxiv, p. 1060.
9. Pringle (1908). Recovery. Lancet, Feb. 20, 1909.
10. Pringle (1908). Death on 1st day. Lancet, Feb. 20, 1909.

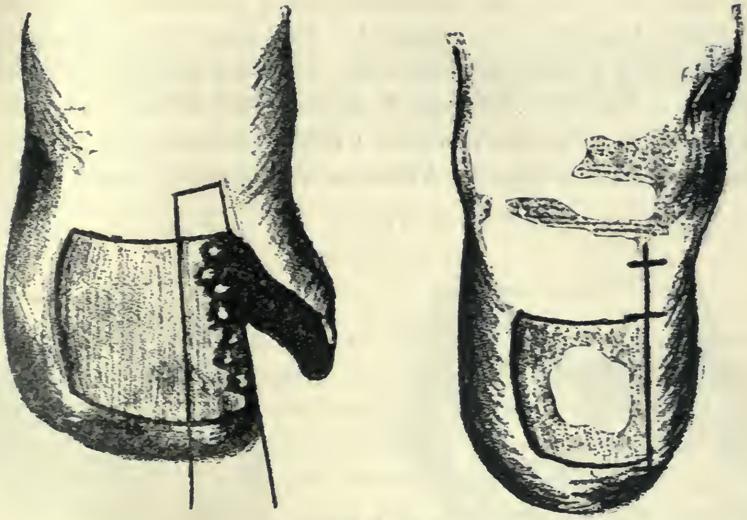
* The operations for tuberculosis were practically all done in two stages, the first being either a hip resection or amputation. The extent of the resection of the pelvic bone varies much. I have, however, excluded all cases in which the resection did not involve the major part of the ilium.

A NEW OPERATION FOR INGROWN TOE-NAIL.

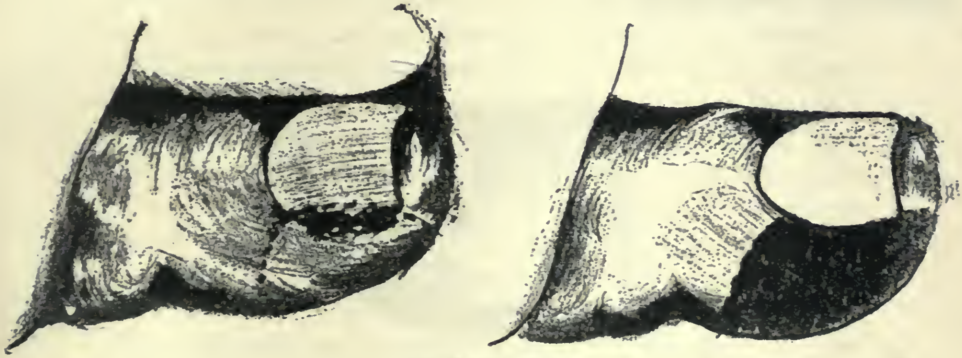
BY S. D. VAN METER, M.D.,
OF DENVER, COLO.

One feels considerable delicacy in claiming anything new in surgery, because it has been well said that "there is nothing new under the sun"; but, so far as I have been able to determine by a careful review of surgical literature, the following operation has not been published, although it is more than probable other surgeons have resorted to the principles involved. That it has not been recognized by the authors of the three most recent publications on surgery, is further justification of my claim to its novelty. Of the numerous operations advocated for ingrowing toe-nail, the operations of Anger, Cotting and von Bergmann are recommended as the best. It is admitted that the majority of cases can be cured by proper dressing, and the appliances, such as are suggested by Taylor and Webb, are of signal assistance in curing this condition without a cutting operation. The unwillingness of the patient, however, to submit to treatment often renders it advisable to perform a radical operation, although we know that with a little patience we shall succeed in effecting a cure without surgical interference.

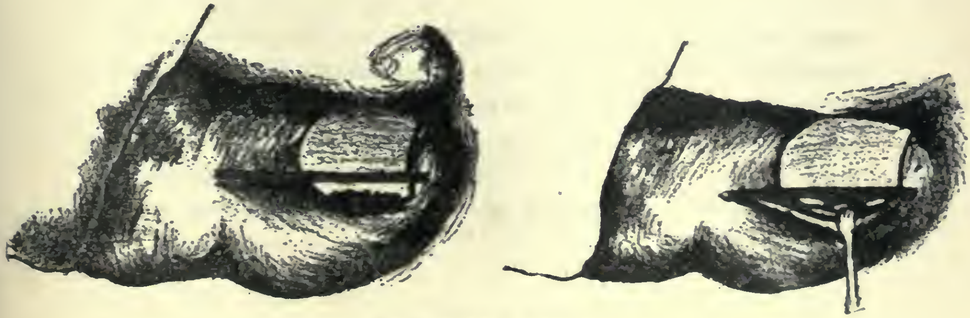
The operation I have devised, and which I find most satisfactory, may be described as follows: After the usual cleansing preparation, and a thorough application of Harrington's solution, a diamond-shaped incision is made, under local anæsthesia, in the lateral aspect of the toe—as shown in Fig. 1. The upper lateral angle of this incision should come to within not less than one-quarter of an inch of the border of the nail, being careful to leave sufficient room in the healthy tissue for the insertion of a suture. The incision is carried down to the periosteum, and a diamond-shaped piece of tissue excised. Three fine sutures, preferably of fine silkworm gut, are used



Anger's operation.



Cotting's operation.



Von Bergmann's operation.

to close the wound, the middle one being placed so as to coapt the lateral angles of the diamond. This draws the overlapping exuberant granulation tissue away from the nail, as shown in Fig. 3. At times, however, to expedite the retraction of this tissue, it is advisable to make a slight nick near the root of nail as shown in Fig. 3. What we should expect, and what is really accomplished by this operation, is the healing of the wound by first intention, having been made entirely in healthy tissue, causing a flattening of the lateral aspect of the toe, and not only effects a cure, but prevents a recurrence of the trouble. No portion of the nail is removed; it is not mutilating; the convalescence is short, and the end result most satisfactory.

Fig. 1.

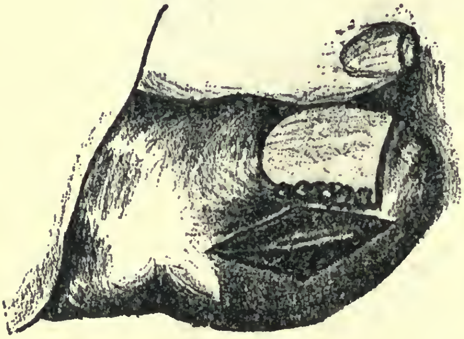


Fig. 2.

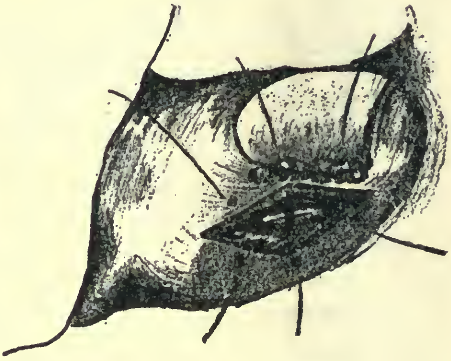
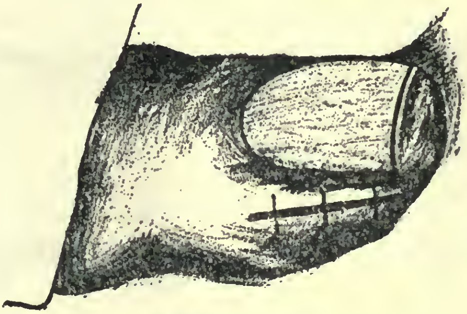


Fig. 3.



Van Meter's operation.

THE TREATMENT OF GONORRHŒAL ARTHRITIS WITH VACCINES MADE FROM THE GONOCOCCUS.*

A REVIEW OF FIFTY-ONE CASES.

BY H. F. HARTWELL, M.D.,

OF BOSTON, MASS.

(From the Pathological Laboratory of the Massachusetts General Hospital.)

STIMULATED by the visit of Sir A. E. Wright to this country in the fall of 1906, a number of cases of gonorrhœal arthritis at the Massachusetts General Hospital during the last two years have been treated with vaccines made from the gonococcus. The total number treated is larger than those here reported, but these have been selected because the diagnosis, according to the accepted clinical standards, seemed sure, and because they have all been seen a sufficiently long time afterwards to form an opinion of the permanency of the results.

It happens that all of these cases were males. In all there was a recent or an old urethral infection. In many there had been numerous attacks, which had left lesions in urethra, prostate, or testicles. Some had suffered other attacks of arthritis which had left crippling joints in their train. They all received local treatment for their urethritis. In some of the obstinate cases this was continued till subsequent cultures of washings from the deep urethra after massage of prostate and vesicles showed the absence of gonococci. We have not been able to note any effect on the urethral discharge by the use of these vaccines, though, of course, this was obscured by the thorough local treatment which was pursued at the same time. In some few cases, however, in which urethral treatment was withheld for one reason or another, while vaccines were being given for joint affections, no improvement in the urethral discharge was observed.

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* Read in abstract before the American Urological Association, June 7, 1909.

The vaccines were made from 24-hour cultures, grown on hydrocele agar slants. From these an emulsion of the gonococcus was prepared by washing off the surface growth with normal salt. This emulsion was killed at 60° C. for an hour, or by allowing it to stand in the ice-box over night, and then exposing it to lysol (1:400) for 12 hours. The number of gonococci in the emulsion was determined by counting, and vaccines were prepared in strengths varying from 100,000,000 to 600,000,000 organisms per c.c. No striking difference was noted between the results with the heated vaccines and those in which no heat was used. When possible, all cases were treated with vaccines made from the patient's own urethra or joint, an autogenous, or else with another strain which had shown good results, a stock vaccine.

Treatment in these cases was begun with a small inoculation, the amount being gradually increased to overcome the tolerance established. The acute were inoculated oftener and in smaller amounts than the chronic. In the former, an initial inoculation was from 10,000,000 to 25,000,000, and as progression was made, rarely exceeded 100,000,000. The vaccines were given at intervals of 2 to 4 days. In the chronic the interval varied from 5 days to a week, and the amount often was pushed up to 500,000,000 or 600,000,000. Occasionally toxic symptoms, such as headache, with nausea and vomiting, followed, but they quickly subsided, and produced no serious results.

In most of the cases an attempt was made to grow the gonococcus from the urethra, and in a few from the joints. The results of the bacteriological examinations follow:

	Positive	Negative	Total
Gonococci grown from urethra.....	21	30	51

Gonococci grown from joints:

	Knee	Ankle	Elbow	Wrist	Total
Positive	1	0	1	0	2
Negative	2	1	1	1	5
Total					7

From the urethra cultures usually showed a mixed growth of gonococcus and staphylococcus. From the joints both positive cases showed a pure culture, while the negative cases gave no growth.

Cole has shown in an analysis of a series from the Johns Hopkins Hospital similar in size to this, that gonorrhœal arthritis is polyarticular, and our cases well illustrate this fact. In 44, or 86 per cent., the infection was multiple at the time of observation, or a multiple involvement was shown in the history. Many which were monarticular at the time of examination gave a history of early mild infection in other joints.

From our observations in the employment of vaccines in these cases, it does not seem that much immunity was obtained by the first few inoculations. In several which were seen early, joints apparently previously uninvolved became acutely inflamed when already 3 to 5 inoculations had been given. It may, of course, be possible that this was caused by too large an inoculation, yet none of these patients exhibited toxic symptoms from their vaccines. It seems more reasonable, however, to look upon it as the clinical course of the gonorrhœal infection, where not enough immunity has been established by the inoculations to overcome a fresh invasion of the micro-organisms.

The following case is cited as an example:

A young man was seen June 22. His first attack of gonorrhœa came on twelve days before, and his right wrist had been painful for five days. Examination showed the wrist swollen, the swelling extending along the radial flexor tendons. Motions of the wrist were painful and limited by spasm. The fingers moved freely. There was a purulent urethral discharge. The wrist was fixed with a splint, and 25 mil. stock vaccine given.

June 24: There was less swelling and tenderness, and the wrist motions were comparatively free without spasm. 50 mil. stock vaccine.

June 29: No pain in wrist, swelling the same. His right shoulder became lame the day before. Given 50 mil. autogenous vaccine grown from the urethral discharge.

July 1: The right shoulder was normal. 60 mil. autogenous.

He did not come for treatment again till July 9. He said he began to have severe pain in his left shoulder six days before, which continued till yesterday. An examination showed tenderness about the joint, especially over the bicipital groove, and there was marked muscle spasm. The right wrist and fingers could be moved freely. No toxic symptoms had been shown after any of the inoculations. The left shoulder was confined with a sling, and he was given 60 mil. autogenous. He did not report again.

It is certain that no lasting immunity is conferred by the vaccines. Six of our patients had a recurrence of their joint infections at varying intervals after they had been discharged. In 5, the reinfection resulted from a fresh gonorrhœa, while in one, no evidence of a fresh attack could be obtained. The interval from discharge to reinfection in these cases was as follows:

	Cases.
3 months after cure	1
4 months after cure	2
5 months after cure	1
1 year after cure	1
1 year and 5 months after cure	1
Total	6

The question of the comparative value of autogenous and stock vaccines is of practical importance. The production of an autogenous vaccine requires the facilities of a laboratory, and even then, in many cases, it is as futile to grow the gonococcus from the urethra as from many of the infected joints. Torrey, Wasserman, and others working with the gonococcus, have found variation in different strains, both in cultural characteristics and in toxicity for animals. The specificity of immune substances would lead us to expect better results following the use of autogenous vaccines and our clinical experience in this series of cases seems to support this view.

Some of our earlier cases which were begun with stock vaccines, afterwards had autogenous, and we were impressed with the greater efficiency of the latter. Since these earlier cases, autogenous vaccines have always been used whenever the gonococcus could be obtained in culture. One can, however, be easily misled in interpreting the results in these cases. Gonorrhœal arthritis shows a variable clinical course, and it not infrequently happens that an acute joint suddenly becomes quiescent, the phenomenon taking place with a rapidity comparable to the crisis of pneumonia. The rapid amelioration in symptoms which has followed the inoculation of autogenous vaccine, must be accepted, therefore, with some reserve.

The following case is one in which stock vaccine was first used, followed by autogenous:

Man, 25 years, admitted to the Massachusetts General Hospital March 6. He had gonorrhœa two years before, when the left ankle swelled, and he was disabled for one month. He first noticed the fresh urethral discharge one week ago, and the following day had a cutting pain in the right hip. Examination showed tenderness without swelling or redness at the right sacro-iliac joint, the motions of the right thigh caused pain referred to this region and to the hip. There was slight swelling, redness and tenderness across the left instep, but motions of the ankle were free.

March 8: Given 25 mil. stock vaccine.

March 14: Still had pain in right hip. 50 mil. stock.

March 19: Pain started in left hip three days ago, and he has been steadily growing worse. He lay with the left thigh flexed. The least motion of the left hip caused intense pain and was guarded by muscle spasm. There was marked tenderness with some swelling over the left groin. The right hip was comfortable, and he was able to move it fairly well. 25 mil. stock.

March 24: The left hip was still held flexed. It was less painful while at rest, but any attempt at motion caused pain, and was attended by muscle spasm. 25 mil. autogenous.

When seen the next day, he lay in bed with the left thigh completely extended. There was no pain, and the hip-joint allowed full motion without spasm. His further course was uneventful. April 1 he was walking about the ward with only slight stiffness, and he was discharged on April 9, with full motion in all his affected joints. He had received three more inoculations.

The following case received only autogenous vaccine:

H., 25 years. Was seen as an out-patient, May 13. His first attack of gonorrhœa was two months ago, and three weeks after this he said he had pains in both knees and the fingers of the left hand. These joints subsided in about a week, and at the end of this time, five weeks ago, the left hip became painful. On examination the hip showed passive motion in flexion to a right angle, with 25° permanent flexion. It was held firmly at a right angle, and allowed no rotation nor abduction. There was one-half inch atrophy of the left thigh and one-quarter inch atrophy of the left calf.

The gonococcus was grown from the urethra. Between May 9 and May 23 he received four inoculations of a vaccine made from this strain, and improved continuously. May 26 there was absolute freedom of motion in the hip, and he walked without limp. November 23 word was received from him that his joint continued in perfect condition.

If we compare the results obtained in the cases treated with autogenous, and those in which stock vaccines were used, we find more evidence in favor of the autogenous. Joints which, after treatment, were capable of complete and full motion without any thickening or adhesions, or without enough thickening to impede their full functionating power, have been classed as "good." Those in which motion was impaired either by adhesions or thickening, have been called "poor." The results in this series were as follows:

	Good	Poor	Total
Cases treated with autogenous.............	19	2	21
Cases treated with stock	23	7	30

A further study of these 51 cases showed that 20 of them were seen within a few days of the onset of their joint symptoms. The remaining 31 had all been through an acute attack before they came under observation, and had been left with disabled joints.

Of the cases seen at the beginning of their attack, 11 were simple hydrops, and all were polyarticular except one. The vaccines diminished their pain and hastened their resolution. Some received massage as soon as the acuteness of the joints allowed. Leaving out those joints which had been disabled from previous attacks, there were only three of these patients who did not recover with perfect results. One of them, when first seen, had an acute infection of the hip, knee, and both thumbs. They all cleared up except the right thumb, which suppurated, and became ankylosed. The second had been through two previous joint infections, which had disabled both knees and one hip. The third attack involved all the larger joints of the extremities except the shoulders and elbows. He was left with a permanently flexed and disabled right hip, with the other joints the same as before. This patient was so piteously crippled and helpless that he could not be moved to the Zander machines for passive motion. The third had an infection of the shoulder, wrist, and fingers, and had two stiff knuckles when discharged.

The following are examples of these acute polyarticular cases:

A negro, 22 years old, was admitted to the wards February 29. He had been suffering for two weeks with pains in his joints, and was confined to bed. Both wrists, both knees, and both ankles were swollen, tender, and painful on motion. There was fluid in the left knee, and a purulent urethral discharge. He received salicylates till March 5 without improvement. March 6 to March 23 he was given seven inoculations of autogenous vaccine, when he was discharged to his home. There was a rapid improvement and disappearance of pain. Twelve days after the first inoculation he was able to walk about the ward. At the time of discharge all the joints were normal except for a little fluid in the left knee, and slight limitation of motion in the left wrist. He came to the Out-Patient, and received four further inoculations, and by April 18 these two joints had cleared up. He reported nine months afterwards with his joints in normal condition.

Man, 23 years, first seen on May 13. Two and one-half years before there had been a multiple gonorrhœal arthritis, and a few months later another attack. He was laid up from work for ten days, and had stiff wrists and a stiff index finger as a result. His present arthritis had come on five days before. Both ankles, both knees, both wrists, both elbows, and the left sternoclavicular joints were swollen, painful, and tender. There was pain in both shoulders and in the sacro-iliac joints. The fingers and toes were swollen. There was fluid in both knee-joints. The urethra showed a purulent discharge. He was helpless and bedridden. Inoculations of an autogenous vaccine were begun on May 19. There was a steady improvement in the acute symptoms and a gradual subsidence of the swelling. June 8 he was able to go about on crutches, but the joints were weak and the ligaments relaxed. He received daily massage, and June 24 could walk without any support. He left the hospital on July 3, and spent the summer in the country, gradually becoming more active. He continued to receive inoculations at intervals of a week to ten days. September 28 he resumed work. All his joints except the wrists and index finger, which had been stiff from his previous attacks, were normal. He had gained 12 pounds. He reported five months later, and was in the same excellent condition.

In nine of the acute cases, the process in the joints had become purulent or seropurulent, with infiltration of the periarticular structures. They were all monarticular. This is the type which seeks surgical care. Six of these cases recovered with joints which were capable of complete and free motion. In two of them, which were both suppurations in the knee-joint, some slight thickening remained as late as 5 months after their discharge, but this offered no obstacle to joint function. With the exception of aspiration, which was done for therapeutic as well as diagnostic purposes, these cases had no operative treatment. As emphasized by Cole, we place great importance on early motion in these joints. Fixation is continued only while pain lasts. Just as soon as the acute symptoms have subsided, they have been placed under the care of Dr. C. H. Bucholz for massage and passive motion, and we assign a large share in the final outcome to this treatment. The vaccines have been kept up while the sluggish induration was being absorbed, although it does not seem that they were very efficient in this stage, and thereby the period of their administration has been much prolonged.

Three of these 9 cases had more or less joint disability after their discharge. One was a suppuration of the elbow, in which there was one-third of the normal arc of motion, with periosteal thickening. Both the other two were wrist-joint infections, one of which became completely stiff, and the other had only about one-half of its normal motion. Vaccines seemed to have no effect on the pain and swelling in these two cases. Œdema in these wrist-joints was so marked that we have thought it must be a determining factor in these poor results. With tissues so swollen, especially in a joint with so many small synovial partitions, there must be considerable resistance offered to the blood stream, and antibodies could not be brought in sufficient abundance to the inflammatory foci. Guided by this theoretical explanation, we have employed active hyperæmia produced by hot air to stimulate the congestion and carry off the œdema from the tissues. With two later cases of wrist-joint infection which were given daily hot air baking, the œdema was reduced, the pain was relieved, and they both had perfect results.

The following cases are examples of suppurating joints:

A. P., 35 years, admitted May 29. Ten weeks before he first noticed a urethral discharge, and eight weeks later, following a chill, the right knee became sore. It was very painful and the swelling had increased. Examination showed the right knee swollen and the capsule tensely distended with fluid. The joint was held flexed at an angle of 45 degrees and no motion was possible. There was a slight rise in temperature, ranging from 100° to 102° and very slight urethral discharge. About 50 c.c. of purulent fluid was removed from the joint at two successive aspirations, which showed gonococci in the smears and in culture. Inoculations of his own vaccine were begun June 3, and on June 16 the acute symptoms had quieted down to permit of light massage. He was discharged from the ward on July 2 with 45 degrees of motion, and came to the out-patient for vaccines and Zander treatment. July 31 he could completely extend his knee and went back to his work. He reported November 14, when the knee allowed free and full motion without fluid. There was a slight amount of periarticular thickening, the circumference over the patella being 2½ cm. more than over the left.

H. B., 28 years, admitted July 11. He had three attacks of gonorrhœa, the last six weeks ago. He first had pain in his left elbow thirteen days ago. Swelling soon appeared, and had rapidly increased. There was no urethral discharge, and examination showed the left elbow flexed at about 40 degrees. It was red, swollen, and tender. The capsule on either side of the olecranon was bulging, and but a few degrees of motion were possible. Swelling extended down the forearm to the dorsum of the hand. About 5 c.c. of purulent fluid was obtained from the joint by aspiration, which showed a pure culture of gonococcus. July 15 an autogenous vaccine was begun. There was improvement, and he was discharged from the wards July 19. Vaccines were continued in the out-patient department, and he was given passive motion on the Zander machines. Treatment was suspended August 31, when there was complete extension of the elbow, nearly complete flexion, with slight limitation in pronation and supination. He reported November 11, and had increased the joint motion so that there was full flexion and extension. There was very slight limitation in pronation, which was accompanied by crepitus. Muscle atrophy was still marked.

Thirty-one, or more than half of our cases, were seen when the acute inflammation had subsided. They came for treatment at periods ranging from one month to a year after their acute attacks. They all had the typical indolent crippling lesions which are the sequelæ of this distressing affection. The joints were swollen, either from periarticular infiltration, intra-articular fluid, or œdema, and had shown little progress. They were stiff, and painful when used. The majority were so disabled that they could not work, especially those in whom the joints of the lower extremity were affected. In 27 of these cases the result of treatment was successful, and they were discharged with complete functionating joints without disability. They have all reported at intervals of a month to a year after their discharge, and in all the perfect joint function has been maintained. In many, the contrast in their physical condition at the time of last reporting and when they first began treatment was striking. The resumption of function in the joints had allowed them to exercise, they had put on weight, and had a rugged healthy appearance. In some in whom disability was slight, the length of treatment was shorter than in the acute cases. In others, with more marked and long-standing changes, it was much more protracted. Infection of the ankles and small joints of the feet was very obstinate. Many of these cases had everted ankles, and the constant strain of walking kept up the irritation. In some of them a successful result was only attained by manipulative correction with rest in bed. The tender areas at the plantar surface of the os calcis, painful heals or talalgia, which were often seen in these cases, was another obstinate lesion. In all it eventually disappeared without recourse to operation. In no one of these cases, however, was a bone spur demonstrated by X-ray.

In 4 of these patients with chronic joints, the result of treatment was not satisfactory. Two were chronic infections of the ankle-joints, one dating back 12 years, another 6 years. They were treated during an exacerbation without effect on the pain or the deformity. Two with multiple joints, improved considerably, but they were both discharged with stiff shoulders.

Among these chronic cases there were 5 with stiff backs. In all except one there was, or had been, involvement of other joints as well. In 4 cases the stiffness had existed for a year or more, while in one, it was of three months' duration. In all of them motions were limited throughout the whole spine, and in any attempt at forward bending it moved as though fused. There was no deformity. There was pain in the lower dorsal and lumbar region, but it was not referred to the anterior aspect of the body. It often interfered with sleep. In one, the X-ray showed thickening about the lower dorsal and upper lumbar vertebræ. Improvement in all these cases was very striking. While they did not recover the complete freedom of motion of a normal back the spinal motions in all were very much increased and were free enough to give them no inconvenience in their work. They were entirely relieved of their pain.

From observation of these cases it would seem that gonococcus vaccines are a valuable therapeutic agent in gonorrhœal arthritis, in all stages of the inflammation except where ankylosis has occurred. They do not, however, seem to be able to prevent extension to fresh joints in early cases, and certainly do not produce enough lasting immunity to prevent recurrence of arthritis. Autogenous vaccines seem to be more efficient than stock, thus corresponding to the known specificity of biological substances.

BOOK REVIEWS.

OPERATIVE MIDWIFERY. By J. M. MUNRO KERR, C.B., C.M., Glas., Fellow of the Faculty of Physicians and Surgeons, Glasgow; Obstetric Physician, Glasgow Maternity Hospital. With 294 illustrations in the text. 8vo, pp. 705. New York, William Wood & Co., 1908.

Since the modern operations of Cæsarean section, vaginal hysterectomy, pubiotomy, symphysiotomy, and abdominal section for extra-uterine pregnancy, tumors, and similar intra-abdominal complications of pregnancy have been evolved and are so often performed in suitable cases by all well-prepared obstetricians, obstetrics has become essentially a part of surgery and the accoucheur to be successful requires a thorough surgical training.

Many years have elapsed since a treatise devoted entirely to operative midwifery has appeared in the English language. The recent volume by Kerr supplies such a want. The work is devoted entirely to the consideration of the indications of the various operative procedures now practiced in obstetrics, and a detailed description is given of the technic of operation involved in each.

Fully one-half of the volume is devoted to the subject of dystocia, and in the subdivisions of this general subject separate chapters are devoted to the consideration of the various conditions giving rise to difficult labor. The causes inherent in the forces of labor, in the birth canal or in the child itself, are systematically considered, and the different abnormalities of presentation, malformation of the child or pathologic changes in the maternal organs are clearly described and, so far as it is possible to do so, are illustrated by excellent plates, many of them made directly from material in the possession of the author.

The obstetric operations—version, forceps, symphysiotomy, accouchement forcé, vaginal Cæsarean section, and the different operations involving destruction of the child—are described in detail in separate chapters. Such pathologic conditions as moles, extra-uterine pregnancy, placenta previa, and the various varieties of hemorrhage form another group of interesting chapters, and, finally, the various accidents occurring to either mother or child at the time of birth are carefully considered.

Few medical men are called upon to conduct a case of labor in which the product consists of a double monster, and even obstetricians of considerable experience will see in a life-time but two or three confinements so complicated; nevertheless, a practitioner may any day find himself face to face with such an obstetrical emergency, and it is therefore necessary for him to know what has been the usual history of such cases and in what way the difficulty in delivery can best be overcome. The chapter devoted to double monsters has been written by J. W. Ballantyne of Edinburgh, and is an excellent summary of our knowledge of this unusual condition.

One of the most important chapters in the book is devoted to the diagnosis of presentation by means of abdominal manipulations, and as this subject has been imperfectly considered in medical literature, the directions given are of unusual practical value.

As a literary contribution, the book is well worth reading, and the judicial manner in which the author marshals his facts and conclusions gives more than ordinary force to his teaching. He is eminently conservative. "A first labor is a trial labor; so with moderate pelvic deformity it is well to have recourse to any major operation only if nature fails after she has been given a long trial." This sentence may be taken as the text upon which the book is developed, and it would be well if all men called to attend women in labor would adopt the same conservative attitude. Few books that have appeared in medicine can be read with more pleasure and profit. The illustrations are new and excellent, and altogether the volume forms one of the most important additions to the literature of obstetrics that has ever appeared.

Henry P. de Forest.

Manual of Operative Surgery. By John Fairbairn Binnie, A.M., C.M., Professor of Surgery in the Kansas State University, etc. Fourth edition. Volume I. Philadelphia, P. Blakiston, Son & Co., 1909.

This book of Dr. Binnie's is rapidly outgrowing the limits which it set for itself at the beginning. In this fourth edition it has become a two-volume work, and this first volume considerably exceeds in its number of pages the entire original work, although an attempt is still made to keep down its size to the requirements of an overcoat-pocket edition. One edition has followed another rapidly and this has testified to the popularity which the book has enjoyed; a popularity due somewhat to its convenience of size and attractiveness of typography, but more particularly to the fact that in it the reader has been able to find the latest things in surgical operative work, while the well-established and classical surgical procedures with which the ordinary books of operative surgery are concerned are omitted. In addition to this, however, that which has commended it doubtless to the majority of readers has been the practical nature of its contents as transmuted, by the experience and common sense of a most practical surgeon, from the literature of the subject. How difficult it has been, in the fecundity of operative surgery at the present time, to keep a book which attempts in any fair degree to present its advances, is well exemplified by the constant growth of this book. There is no opportunity for criticism as to the manner in which the author has carried out his scheme; it is altogether a useful and commendable work.

SURGERY OF THE UPPER ABDOMEN. By JOHN B. DEAVER, M.D., Surgeon-in-Chief to the German Hospital, and A. P. C. ASHHURST, M.D., Surgeon to the Out-Patient Department, Episcopal Hospital. In two volumes. Volume I, pp. 468, 76 illustrations. P. Blakiston's Son & Co., Philadelphia, 1909.

The first instalment of this work on the Surgery of the Upper Abdomen is devoted to the surgical lesions of the stomach and duodenum. The liver and bile passages, the pancreas, and the spleen, are to be considered in the second volume, the date of publication of which is not announced.

The general subject has been taken up in a broad and comprehensive way, the first fifty-five pages being devoted to the anatomy and embryology of the parts concerned, and to the physiology of digestion. The latest views on these matters are well summarized. The anatomical cuts would have been more useful to the average reader if references by line or letter to the different structures or organs had been added. The applied physiology is largely a résumé of the work of Cannon, Blake, and Murphy (published in the *American Journal of Medical Sciences,* and the ANNALS OF SURGERY, in 1905, '06, and '07). It is well done, and is both clear and readable.

The chapter on General Diagnostic Considerations might with advantage have included wider application of the anatomical and physiological facts previously described, but no other fault can be found with it. Particularly to be commended is the opening page on which the authors object to that conception of the surgeon's function—in intractable cases of disease of the upper abdomen—which, as they say, " is colloquially referred to as ' taking off the lid.' " We believe, as they seem to believe, that the expression might be regarded as an index to the surgical tone of the man to whom it applies. Attention might here have appropriately been called to the frequency with which abdominal symptoms,—rigidity, distention, etc.—are associated with supradiaphragmatic lesions although the abdomen and its contents are not directly involved. This has been a fruitful source of error and deserves emphasis.

The chapter on Benign Diseases of the Stomach and Duodenum is excellent. The differing claims of the internists and the operators are set forth and the evidence weighed with reasonable fairness. In the chapter on Gastric Ulcer the authors summarize their views (apparently but not unmistakably referring to benign diseases generally) as follows:

" Surgical treatment allows 95 to 98 per cent. of these patients to recover. Medical treatment allows 75 to 80 per cent. to recover. Surgery permanently cures practically every patient who recovers. Medicine permanently cures only 30 to 40 per cent. of its patients. Medical treatment is long and uncertain. Surgical treatment is rapid and sure." This is possibly a little extravagant, but they add that they have no desire to be understood as urging surgical intervention in every case of gastric ulcer, and continue: " Medical treatment should always first be tried, and only when methodical and energetic medical treatment has failed to cure the patient, after it has been persisted in for a reasonable time, or when several temporary cures have resulted in ultimate relapses, only then, we repeat, is surgical treatment to be considered in patients with acute, actively ulcerating lesions. In ulcers such as these, it is mainly on account of the complication of hemorrhage that the surgeon's advice is sought. Perforation is universally acknowledged to call for surgical intervention at the earliest possible moment. But in regard to hemorrhage there is still dispute."

As to the choice of operation in gastric perforation, although the facts now before the profession cannot be said to justify the final formulation of rules, we believe, with them, that at present in any case where it is not specifically and positively contraindicated, gastrojejunostomy should be performed.

Pylorospasm is accurately described as "only a symptom of some other malady," and the somewhat analogous condition of infantile stenosis of the pylorus is likewise regarded as a muscular hypertrophy brought about by persistent spasm due to irritation from some cause, such as hyperacidity of the gastric juice, or a small erosion or fissure.

The need for distinguishing the vomiting caused by acute dilatation of the stomach, when post-operative, from that due to the anæsthetic and from the vomiting of peritonitis, is emphasized and the conditions differentiated. Secondary gastric dilatation is assigned in the great majority of cases to obstructive causes, and the safe prediction is made that the so-called "atonic" cases will grow rarer—just as vesical "atony" has almost vanished—as the surgeon is given more opportunities to find the underlying cause of the condition.

Syphilis of the Stomach is considered in three pages. The fact is not noted that in nearly every case of so-called gastric syphilis that has been reliably reported there have been associated lesions—often gummata—of the liver. Many of the stomach conditions found may well have been secondary to the hepatic disease. There are some recent exceptions to this general statement but, for other reasons, most of them are unconvincing as to the specific character of the gastric lesions described.

Carcinoma of the Stomach is very fully and satisfactorily dealt with. There can be no dissent from the assertion that "the presence of cancer should be suspected when chronic gastric catarrh exists without any discoverable cause (such as abuse of food, of alcohol, of drugs; circulatory disturbances of the heart or liver; or diseases, such as gall stones, gastric ulcer, etc., which would cause some definite lesions in the region of the stomach), especially if this chronic gastritis be in a patient over forty years of age, and if it be attended by loss of appetite for meats (Kocher)."

It is also true that if a tumor exists the diagnosis is less difficult,—so many diseased conditions not associated with swelling or new growth being then eliminated. But that the characteristic pyramidal shape of a pyloric growth can *frequently* be recognized we take the liberty of doubting, in spite of the authority of Kocher. We agree with the further statement that " occult blood in the stomach contents and fæces is the most valuable of the laboratory findings. In non-malignant ulcerations of the stomach, rest in bed with milk diet will cause the disappearance of occult blood. In cancer no treatment has any effect."

The practitioner to-day has, perhaps, no more difficult decision to make than in doubtful cases of this character at a relatively early stage. That decision will necessarily, for some time to come, depend not merely on the lapse of time or—in the absence of tumor—upon the persistence of catarrh, in spite of diet and medical treatment, but also upon the temperament of the physician, his previous experience with surgery—and surgeons—and his willingness to share responsibility for an operation which may prove to be only diagnostic—and that negatively. To say that " it seems to us that every case diagnosticated *certainly* as carcinoma of the stomach before operation is a disgrace to the attending physician, provided he has had the patient under treatment for more than a few weeks " seems a little intemperate in expression, while the context shows the very vagueness—due to the imperfection of our knowledge—that is the cause of the delays of which the authors complain. They speak of " that space of time "—referring to " a few weeks "—as if it were a definite period, and contend that within it the conclusion should be reached that an " anatomical basis " for the symptoms exists and—a non sequitur—that this can be removed only by operative means.

These remarks are merely in palliation and not in support of delay. With the general contention of the authors we are entirely in sympathy, and as for some time to come errors in one direction or the other will be unavoidable, we believe that it will be better for the patients if they are in the direction of hastening rather than postponing surgical intervention.

In Stab-wounds of the Abdomen, when the absence of protrusion of the omentum or escape of abdominal contents renders the existence of penetration of the abdominal cavity uncertain, they wisely advise that the surgeon make a layer-by-layer dissection, arrested at first at the aponeurotic and then at the peritoneal plane of the abdominal wall and they add: " We are thus insistent upon this cautious approach, and upon determining beforehand whether the peritoneal cavity has been penetrated by the weapon, because it often happens that on opening the abdomen widely in these cases inspection shows no evidence of intra-abdominal lesion. and very extensive search becomes necessary to exclude the possibility of visceral injury; and if none be found to exist, and it is shown that the vulnerating weapon itself had never opened the peritoneal cavity, the surgeon will have subjected his patient to a quite unnecessary and by no means trivial operation. If, however, the fact of abdominal penetration has been definitely determined in doubtful cases by the method just described, the surgeon will be quite justified in his extensive intra-abdominal manipulations, even though no lesion be found more serious than hemorrhage from an omental vein."

In Gunshot Wounds of the Stomach early operation in civil life, and non-interference in military practice, are advocated, statistics demonstrating the correctness of both positions.

The chapters on the Technique of Operations while necessarily excluding many procedures still employed, represent on the whole the best methods of to-day, and are as well adapted to enlighten the intending operator as any with which we are familiar.

The statistical matter throughout is most useful and informing. Every effort has obviously been made to bring it up to date, as is exemplified by the reference (page 287) to the figures of Mikulicz (1901), Hahn (1898), and others, as "rather ancient."

The illustrations as a rule are excellent. The legends err on the side of brevity. We do not like to see adhesions involving the sigmoid flexure described as "perigastric," even though the underlying cause is thereby indicated.

The book is well written. We were inclined to criticize a sentence which speaks of a summary "as illustrative of the interrelation which unites the digestive processes in an orderly series of successively dependent events," but found that Cannon was responsible for it and not the authors. We see no reason why an American should write "endeavour" or "candour," or why any one should write "develope" and "developement." Certainly no one should write: "its greater liability to fatal hemorrhage and to perforation make a sudden death probable" (page 205); and the grammar of "the chief artery met with in the upper abdominal wall is the internal mammary or some of its terminal branches" (page 2) is scarcely better. We rather like the word "puked" (page 154) though its use has come to savor of literary affectation. Postempski is entitled to have his name spelled either without a "p" (page 267), or with a "p" (page 263), and not in both ways.

In the index—which is well-made—*im*perforation of the œsophagus refers to page 179 and not to page 129, where perforation is mentioned.

But all these criticisms are trivial. The book is a notable contribution to one of the most important departments of modern surgery, and reflects credit upon both the industry and the intelligence of its authors and—in its physical characteristics—upon its publishers.

J. William White.

CORRESPONDENCE.

TORSION OF SPERMATIC CORD.

Editor Annals of Surgery:

The present report of a single case is submitted on account of its rarity, as an addition to the literature of the subject.

A man, aged thirty-two, noticed a swelling in the left inguinal region October 10, 1908. As a boy he had developed a hernia of which he was apparently cured by truss pressure. During the past ten years, however, he had at times noticed a swelling in the inguinal region. When he again noticed this swelling, at the last date mentioned, he applied a truss after having apparently reduced the swelling, and was able to attend to his usual occupation for the day, suffering no inconvenience; but about midnight, after retiring, he began to suffer pain in the inguinal region and again noticed the swelling. This pain persisted and became very acute with increase of the swelling, and when I saw him, forty-eight hours after, he was suffering intense agony. On examination there was found a tense, painful swelling extending from the external inguinal ring to the bottom of the scrotum; he also had severe abdominal pain. He was nauseated, and vomited during the day, but his bowels had moved normally. His temperature was 100°; pulse 104. The enlargement was irreducible and exquisitely tender; dull on percussion. An inguinal incision was made as in a Bassini operation for hernia. After the superficial fascia had been incised a mass almost black in color presented itself in the wound. The condition, upon examination, was found to be due to a torsion of the spermatic cord, with necrosis of the testis. The twist in the cord was from left to right, that is, from without inward, and was comparatively easily untwisted. The whole necrotic mass up to the external ring was removed. The usual steps of a Bassini operation, including the splitting of the external oblique muscle, completed the operation. No evidence of a previous hernia was detected. An uninterrupted recovery followed.

Moses Salzer,
Cincinnati, Ohio.

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ORIGINAL MEMOIRS.

INTRAHUMAN BONE GRAFTING AND REIMPLANTATION OF BONE.

BY SIR WILLIAM MACEWEN, F.R.S.,

OF GLASGOW

Regius Professor of Surgery in the University of Glasgow.

INTRAHUMAN bone grafting is sometimes necessary to make good osseous defects brought about by disease or injury. The following case in which the greater part of the shaft of the humerus was restored by intrahuman transplantation occurred thirty years ago, and as the boy who was then operated on is now a man in regular employment, the details of the case are here presented in their entirety. Besides that case three others are mentioned,—one illustrating human reimplantation of the flat bones of the skull and two of restoration by transplantation of human jaw bones. In both of these latter the operation was performed for the removal of marked deformity as well as to restore the function of the mandible. A fourth case is referred to as a note.

These cases are quoted as examples of many others in which bone grafting and transplantation of bone has been successfully performed by me. It is to be noted that the periosteum plays no part in the bone reproduction after transplantation, and in the majority of the cases referred to the periosteum was not transplanted along with the bone.

Intrahuman Transplantation of Bone. Experiment, and Result Thirty Years After.—W. C., aged 3 years, was admitted into the Royal Infirmary, Glasgow, under my care on July 17, 1878, in an emaciated and exhausted condition from suppuration in connection with necrosis of the right humerus, evidently from osteomyelitis.

He presented the appearance of a much neglected child. The right arm was greatly distended and fluctuant from shoulder to elbow. An incision gave vent to fourteen ounces of thin, fetid pus. When the abscess was evacuated, the shaft of the humerus was found to be totally necrosed and already separated from its head near its epiphyseal junction. At the condylar epiphysis crepitation was likewise elicited. The bone was dark colored and fetid.

The arm was dressed and the patient was placed on a generous diet and otherwise attended to, in the hope that his strength might improve and that he would thereby be placed in a better condition for the removal of the necrosed shaft. Notwithstanding the treatment, the daily discharge of fetid pus was great, and as the amount was not much lessened at the end of three weeks, it was considered advisable to remove the source of irritation. This was done about nine weeks after the onset of the disease.

The exposed loose bone was divided near its centre into two parts which were consecutively withdrawn. The two portions removed comprised the whole humeral diaphysis. The periosteal tube which remained was covered with a thick layer of granulation tissue which was soft throughout except at the proximal extremity, where the finger introduced into the tunnel detected rough, osseous plaques of bone. This tunnel was stuffed with carbolized lint and the arm was fixed on a splint. The tunnel left by the withdrawal of the bone gradually coalesced from the epiphyses toward the superficial openings without the formation of new bone, except for a short distance from the head of the humerus, where about an inch and a half of shaft had formed three months after removal of the dead shaft.

Four months after the removal of the necrosed diaphysis, a spike-like terminal extremity was found attached to the proximal portion. The measurement from the acromion process to the end of this tapered process was two inches. From the whole of the remainder there was no osseous deposition. He was seen monthly for some time but no further growth of bone followed.

Fifteen months subsequently he returned to the hospital, his parents desiring that the arm should be removed, as they said it was "worse than useless," inasmuch as he required the other arm and hand to look after the flail-like one which was constantly dangling loosely by his side. The condition of the arm was then as follows:

The bone showed no definite increase since he had left the hospital. When the limb was allowed to hang by his side, the measurement of the proximal portion of the humerus, taken from the acromion process to the distal extremity of the proximal portion, was nearly two inches. In form, the proximal fragment was conical, tapering from the rounded head to a narrow, spike-like extremity. From this to the condyles there was a complete absence of bone, there being nothing but soft tissues in the gap. The muscular power was good, but when he attempted to raise his arm a contraction of the muscles took place, the condyles being drawn toward the proximal extremity, while some fibres of the deltoid raised the spike-like process of the upper portion, causing it to project as if about to penetrate the skin. Here the action ceased, the soft parts in the gap appearing like a rope during the muscular contraction. He could not raise his forearm to his breast. If one caught his arm firmly with the hand placed over the gap, so as to keep the condyles fixed and separate from the upper fragments, then the patient could elevate his forearm toward the chin. The power was there, the lever and fulcrum were wanting. It was determined to supply these by transplantation from other human bones.

In the wards there were numerous cases of marked anterior tibial curves, from which—in order to rectify their deformity—wedges of bone had to be taken, and these were utilized as transplants. An incision was made into the upper third of the humerus, exposing the head of the bone. Its extremity for fully quarter of an inch was found to be cartilaginous. In order to refresh the bone, the cartilaginous, spike-like process was removed, leaving then a portion of bone which measured one inch and three-quarters from the tip of the acromion process. From this point a sulcus about two inches in length was made in the soft parts, in a downward direction between the muscles. The former presence of bone was nowhere indicated; there was no vestige of periosteum, and the sole guide as to the correct position into which the transplant was to be placed was an anatomical one.

Two wedges of bone were then removed from the tibia of a patient æt. 6 years, affected with anterior curves. The base of these osseous wedges consisted of the anterior portion of the tibia, along with its periosteum, the wedges gradually tapering toward the posterior portion of the tibiæ. After removal, they were cut into minute fragments with the chisel, quite irrespective of the periosteum. The bulk of the fragments had no periosteum adhering to them, they having been taken from the interior of the bone.

They were then deposited into the muscular sulcus in the boy's arm and the tissues drawn over them and carefully adjusted. The wound healed without pus production. Two months after, a portion of new bone an inch in length and three-quarters of an inch in thickness was firmly attached to the upper fragment of the humerus. In running the finger from the head of the bone toward the graft, the latter could be easily distinguished by the sudden increase in the breadth of the shaft at the point of junction of the old and new portions of bone. Now, instead of the former sharp spike-like extremity, the upper fragment ended in an obtuse terminal. Here all the grafts proliferated, grew to one another and also to the extremity of the proximal portion.

Two other wedges of bone of larger size than the first were similarly dealt with and inserted two months subsequently to the first graft, and a third couple were placed in position five months after the first. These filled the gap in the arm to the extent of four and a quarter inches, the humerus then measured six inches in length. Soon the utility of the arm was greatly restored.

This boy, from having been in the wards for a considerable period, began to assume "airs" toward some of the boys of his own age in the ward, and one of those seized an opportunity of "setting things right," whereby the first was thrown and had his restored arm fractured between the junction of the second and third transplants. This necessitated the exposure of the bone, the two fractured extremities of which were refreshed, sutured and fixed. The two extremities united just as a fractured normal bone would. Since this time he has been kept somewhat under observation, the patient making occasional visits to report.

Seven years after dismissal from the hospital, the humeral shaft was found to have increased in length by one and three-quarter inches, being now seven and three-quarters, and it had increased in circumference to a marked extent and had assumed a somewhat irregular shape. The length of the sound arm had however considerably outstripped the length of the transplanted humerus. The patient could use his grafted arm for a great many purposes—taking his food, adjusting his clothes and in many games.

It is now thirty years since the humeral shaft was rebuilt, and during the greater part of this period the man has depended upon his physical exertions for the earning of his livelihood. He worked as a joiner for many years, and now is an engineer's pattern maker. His grafted arm has increased in length, but not proportionate to the increase of the sound one. Measurements: The grafted humerus measures, from the tip of the acromion to tip of internal condyle, 10 inches, but following the curve in the bone, it is 11 inches long. The sound humerus from same points measures 14 inches—3 inches longer than the other.

Photos: X-ray.—A skiagraph (kindly taken by Dr. Macintyre, Glasgow) shows that the increase in length of the affected arm has taken place almost entirely from the proximal epiphysis, as the new bone has been interposed between the proximal epiphysis and that portion of bone which grew from the transplantation. All but a minute portion of the distal epiphyseal cartilage was destroyed at the time of the osteomyelitis and, consequently, little growth in length would be expected from this extremity.

The increase in length of the diaphysis, which has occurred from the proximal epiphyseal cartilage, may be taken as an index of the amount of growth which usually occurs from the proximal humeral epiphysis.

Data Bearing on the Increase in Length and Breadth of Bone.—These facts corroborate and supplement some of the deductions made by John Hunter from experiments performed by him on the lower animals. He bored two holes in the tibia of a pig, one near the upper end and the other near the lower; the space between the holes was exactly 2 inches. A small leaden shot was inserted into each hole. When the bone had increased in length by the growth of the animal the pig was killed and the space betwen the shot was still the same, exactly 2 inches. He inferred that "bones are not elongated by new matter being interposed in the interstices of the old."

Probably what is meant is that new additions of bone will be made to the length of the diaphysis from either epiphysis. To that extent the case detailed here agrees and shows that the diaphyseal increase in length occurs in the same way in man.

In this human case, however, the distal epiphyseal cartilage had been rendered in great measure functionless by disease, and the grafted portion, which was at first contiguous with the distal epiphysis, has remained nearer that end, while the increase in length has occurred mainly from the proximal epiphysis, and consequently the new bone has, for the most part, formed between this epiphysis and the grafts. At the same time it is interesting to observe that though the distal epiphyseal cartilage was for the most part destroyed, the epiphysis has increased greatly in bulk, though it is probably not quite of normal size. The grafted portion of tissue, which is easily recognized from the rest of the shaft by form and contour, has increased markedly in thickness and also somewhat in length, so that there has been here interstitial osseous increase.

It is presumed by some that the increase in length of the diaphysis comes mainly from the epiphyseal line toward which the nutrient vessel runs. In the present case the length of the humerus from the tip of the acromion to the internal condyle is 10 inches, and from the same points on the sound limb the measurement is 14 inches. If the measurement be taken following the humeral curve on the grafted humerus, then the length is fully 11 inches, and perhaps this is the fairer measurement if the increase in bone has to be considered.

After the 4½ inches of bone had been added to the limb by grafting, 28 years ago, the length of the humerus then measured fully 6 inches. If the measurement following the curve of the bone as it is now, be taken, then the length at present is 5 inches more than formerly, namely 11 inches. The greater portion of this increase in length has come from the proximal diaphysis, but still not the whole, as there has been an interstitial growth between the fragments of the transplant, as their original form has been altered, and the irregularities constituting the various parts have been separated from one another by interposition of new osseous tissue. Though there are no positive measurements to go on relatively to the increase of interstitial growth in length of the part which had been grafted, still 1 inch would be a rough estimate of that increase,—the part that had been grafted would now measure about 5¼ inches in length instead of 4¼ as formerly. This leaves 4 inches of new growth to have come mainly from the proximal diaphysis. It also leaves 3 inches of shortening between the length of the sound and that of the grafted arm. Could this 3 inches have been made up were the distal epiphysis in normal condition? If so, the increase in length from the proximal epiphysis (if it were normal in this case) would only have been 1 inch less than that of the distal.

On many occasions subsequent to this bone-grafted humerus, grafting, transplanting and reimplanting of bone have been successfully practiced by me, in the human subject, both in the bones of the diaphyseal extremities and in the flat bones of the skull, in order to make good defects arising from many different causes. It would occupy too much space to give details of all these cases—three out of the number must suffice.

Mosaic Work of Bone. Skull.—Can a flat bone, such as those of the cranial vault, continue to grow and its elements proliferate after it has been deprived of its periosteum and has been reimplanted? There have been many opportunities of testing this, from which the following observation may be cited:

CASE.—A weak, ill-fed boy, æt. 9 years, was admitted into Ward 29, Glasgow Royal Infirmary, in January, 1884, suffering from a compound comminuted fracture of the skull, with penetration of the brain substance, received about two hours previously by the fall of debris from a chimney. The brain symptoms are not referred to here.

There was a wound situated over the left side of the head of a somewhat crescentic shape, and extending from above the middle of the left eyebrow to an inch behind the auriculobregmatic line. The depressed portion was somewhat elliptical, with very irregular margins. It measured at its broadest part 2½ inches. All of these portions of bone were depressed below the level of the skull, most of them having penetrated the brain membranes into the brain tissue. These portions of bone were all elevated. It was found that they consisted of 11 pieces, the periosteum having been scraped by the injury from all of these, with the exception of the most posterior one, which was only partially denuded. Many of them were infiltrated with lime debris, brick-dust, etc.

These pieces as they were elevated, were placed in an aseptic solution. They were then pared with a chisel in order to remove the debris. This was especially necessary over the external surface, where they had been scraped and ingrained with dirt. They were afterwards thoroughly washed in an aseptic solution, divided into fragments and replaced. In this way a mosaic work of 14 pieces of bone was formed. It was difficult to retain these in position, owing to four things. First, to the extent of the osseous defect; second, to the fact that the dura mater had been so extensively lacerated and torn that it formed a very irregular floor to rest the fragments upon; third, to the great bruising and crushing of the scalp, which rendered it difficult to bring the several pieces into apposition, and made sloughing of a part of it almost certain; and fourthly, to the force of the cerebral impulses, which caused a distinct movement of the fragments, producing crepitation by the one rubbing against the other. It was feared that owing to these four circumstances some of the fragments would be shed.

It is to be borne in mind that the periosteum had been by the injury entirely removed from all these fragments, except the most posterior one, and that most of them had to have their external surface pared with a chisel. The soft tissues were brought together as well as possible and the wound was dressed.

On the sixth day after the operation, the wound was examined. A portion of the anterior aspect of the flap, which was lacerated and contused, had sloughed, and already the process of separation from the living part had commenced. On the tenth day the wound was re-examined and this portion of the slough was removed. It was then seen that four fragments of bone were exposed, two of which lay side by side and presented a striking contrast. The one was suffused with the pinkish blush of life, the other with the pallor of death. The condition of the remaining exposed fragments was doubtful, one of them however being very pale. On the twenty-first day, at the next dressing, two pieces of bone were found to have shed, while all the remainder had lived. The wound was all but healed. At the termination of a month it was firm.

Had that large osseous defect, about 2½ inches in greatest breadth, extending from the middle of the left eyebrow to the auriculobregmatic line been left without this mosaic work of reimplanted bone, the cranial periosteum, if any of it was left at that part, would have failed to have covered the defect with bone, and a permanent fibrous covering transmitting the cerebral impulse would have marked the seat of injury. Yet, here we re-implant the osseous fragments, and the majority of them live, grow and throw out ossific matter sufficient to unite them individually to one another and to the rest of the uninjured cranium.

Ten years after this operation, the lad was examined. He was then 19 years old, strong and robust. The skull was firm all over, the bone over the site of prior injury had grown in proportion with the rest of the skull.

CASE.—*Restoration of Transverse Ramus of One-half of the Jaw by Transplantation of Bone.* A girl, 15 years of age, had the horizontal ramus of the lower jaw on one side extirpated from a diseased condition in childhood. The remaining ramus was by subsequent contraction displaced, so that it lay with its mental extremity nearly in contact with the ascending ramus of the opposite side. The remaining portions of the jaw were atrophied from disease. The teeth of the upper jaw projected over space. Mastication was in abeyance. Saliva constantly trickled from the defect. An otherwise beautiful face was hideously deformed.

Many surgeons and dentists had been applied to in turn, in the hope that they might rectify the deformity. The former would say that they could do nothing, but would advise the dentist to be consulted, as a plate might be introduced. The dentist would look at the gap and say it was impossible for them to put in a plate until the surgeon would give the patient a something to rest the plate upon.

It was resolved to try the effect of transplantation of bone, although the difficulty of securing asepsis so near the oral cavity was evident.

The first step consisted in freeing, by an incision through the skin, the extremities of the ascending ramus of the jaw on the left side and the horizontal mandible on the right. This was difficult without opening the mucous membrane, as it was so closely adherent to the extremities of the atrophied bones. After this had been accomplished, a portion of a human rib, of size sufficient to fill the gap between the left ascending ramus and the middle line of the jaw, was removed subperiosteally, divided longitudinally into strips and inserted into the gap in the soft tissues and secured to the bones on either side so as to keep the right mandible in its proper position. The soft tissues were then closed over it and the wound was dressed and healed.

One small portion of the transplanted bone became loose, and projecting against the scar, was shed. The remainder lived, slowly augmented in volume until firm union between the ascending right ramus and the left mandible was secured. She could then open and shut the lower jaw and use it freely. The lips came together, the overflow of saliva from the mouth ceased. The contour and symmetry of the face was restored. Some months afterwards the dentist was able to introduce a plate which rested on the newly-formed jaw, not only aiding mastication, but enhancing the appearance.

It is now six years since the restoration of the lower jaw and the transplanted portion has grown thicker and an increase commensurate with the development of the face has ensued. The increase in length has occurred principally from the lower extremity of the ascending ramus. She is now perfectly well, can use the mouth freely, for mastication, she speaks well and the now symmetrical and beautiful face bears no mark of scar, as the slight one which remains is hidden under the jaw.

A second somewhat similar case, though of less extent and presenting fewer difficulties was likewise operated on with a good result.

Professor Cameron, of Toronto, Canada, has reported to me that he had seen and examined a man in which I had 20 years previously transplanted about five inches of the tibia, and that the limb was now a thoroughly sound, reliable member which enabled the patient to engage in hard laboring work. The transplanted portion was however much thicker than the other parts of the tibia.

NOTES ON DERANGEMENTS OF THE KNEE.

BASED UPON A PERSONAL EXPERIENCE OF OVER FIVE HUNDRED OPERATIONS.

BY ROBERT JONES, F.R.C.S.,

OF LIVERPOOL, ENG.

A CLASSIFICATION of the mechanical conditions which give rise to derangements of the knee is difficult in the present stage of our knowledge. It is the more needful therefore to add our experiences and impressions to those already chronicled. Without including operations for disabilities arising from causes extra-articular, I have opened the knee joint over five hundred times, and in spite of this perhaps unique experience, I am quite prepared in cases even with classical symptoms to find my diagnosis wrong. A young woman dancing, a cricketer hitting to leg, an old lady removing the bed clothes with her foot, a direct blow on the knee, a trip, a twist, a jar, a miner working with fully flexed knee—in each case something gives way. The events following the sudden symptoms may be widely different. In one case the joint may have locked; in another acute pain is present; in another, obstinate effusion may occur; in another pain, effusion, and locking are absent, and despite these differences the diagnosis in each case may be the same. It is not my intention in this paper to statistically summarize my experiences, but rather to deal with the subject as it has affected me from the clinical side. On looking over my notes, I find a long list of affections upon which the disabilities depend, the most frequent of which are: *Injuries to the semilunars, synovial fringes, joint lipomata, loose bodies, exostoses, injuries to ligaments, bony separations, dislocation of the patellæ.* The most common of these is injuries to the semilunars.

Before proceeding to the discussion of these specific conditions, it will be well to restate certain anatomical points in reference to the mechanism of the knee and the attachment of the cartilages.

ANATOMY OF THE KNEE JOINT.

The knee is a modified hinge joint in which the articular surfaces of the bones are not closely adapted to one another, and in which there is never more than a small area of the femur in contact with the tibia in any position of the joint. This allows a slight degree of sliding movement and of rotation to take place in addition to the hinge movement.

The great strength of the joint is dependent on the integrity of the crucial ligaments and of the extrinsic ligaments and muscles. It is therefore necessary to give some account of the ligaments and of the semilunar cartilages so far as they have a direct bearing on internal derangements of the knee, especially displacements of the cartilages.

The external lateral ligament consists of two portions, a short inconstant posterior portion and a long anterior portion which, along with the tendon of the biceps, strengthens the joint on the outer side. It is a rounded cord extending from the external tuberosity of the femur to the head of the fibula, where it is attached between the two portions of the tendon of the biceps. It is entirely distinct from the capsule of the knee joint and is separated from the external semilunar cartilage by the tendon of the popliteus and the intervening bursa (Fig. 1).

The internal lateral ligament is a structure of great importance, for it plays a part in the production of the common displacements and injuries of the internal semilunar cartilage. Its superficial aspect is shown in Fig. 2, in which it appears as a long somewhat fan-shaped band. Its deep aspect, however, is intimately blended with the capsule of the joint and is firmly attached to the internal semilunar cartilage (Figs. 1 and 3). It is to be noticed that its deep fibres are really shorter[1] than those of the ext. lat. ligament, and consequently the internal semilunar is very closely moored to the internal condyle of the femur, a fact to which we shall refer again.

The semilunar cartilages are crescentic discs, thick at the convex border and thin at the concave margin, hence they are wedge-shaped in transverse section. Each cartilage assists the opposite lateral ligament in resisting lateral movements of the leg, for it acts as a wedge between the tibia and femur and helps to make the crucial ligaments tense.

The semilunar bodies consist of a core of fibrous tissue, arranged transversely and longitudinally, with a covering above and below of hyaline cartilage. The longitudinal fibres are continuous at the cornua with the fibres attaching them to the tibia, a few of these fibres sometimes are continuous in front from one cartilage to the other, forming the inconstant and unimportant transverse ligament.

At the convex border, fibres of the capsule blend with the transverse fibres of the matrix of the semilunar. The fibres coming from below are rather stronger and form the so-called "coronary ligaments," which are really only the portions of the capsule between the semilunars and the tibia.

FIG. 1.

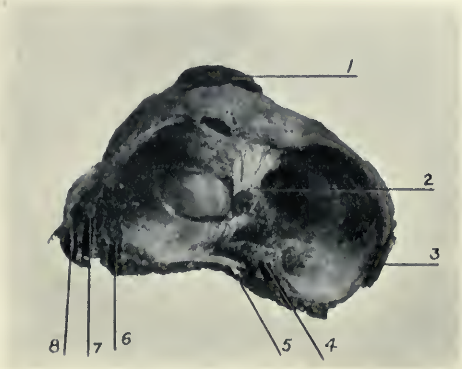


FIG. 2.

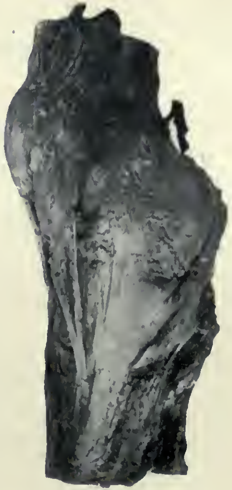
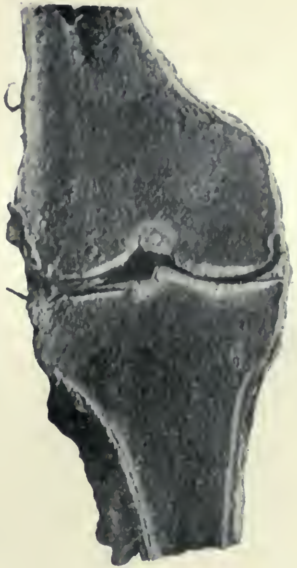


FIG. 3.



ANATOMY OF THE KNEE JOINT.

FIG. 1.—1, ligamentum patellæ; 2, anterior crucial ligament; 3, internal lateral ligament; 4, posterior crucial ligament; 5, fasciculus from posterior end of external semilunar; 6, tendon of popliteus; 7, external lateral ligament, 8, bifurcation of tendon of biceps.

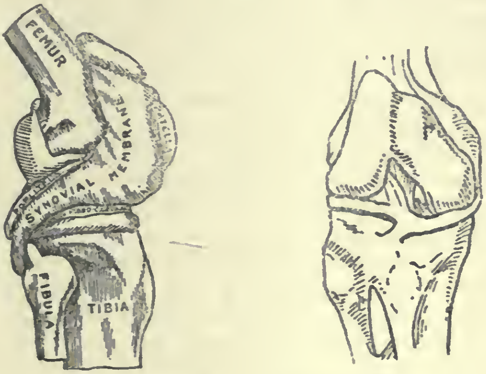
FIG. 2.—Internal lateral ligament. The insertion of the vastus internus in exceptionally long.

FIG. 3.—Saggital section through internal lateral ligament, showing attachment to semilunar cartilage.

The external semilunar is separated from the capsule at the point where it is crossed by the tendons of the popliteus, while at its posterior horn a special slip of attachment runs up to be attached to the popliteal notch of the femur along with the posterior crucial ligament (Fig. 1).

On the other hand, as is shown by the accompanying figures, the internal semilunar cartilage is attached to the capsule along the whole of its convex margin, and is firmly attached to the strong internal lateral ligament as shown in the accompanying sections. The anterior cornu is always attenuated and its attachment to the tibia is never very strong and often very slender. It is easy to see that a sudden strain on the internal lateral ligament, especially if the femur is being rotated inward on the tibia, will tend either to detach the anterior cornu or split the cartilage longitudinally, or in rare cases cause a transverse rupture opposite the attachment to the internal lateral ligament.

Fig. 4.



Structure of the knee joint.

It may be stated briefly that flexion of the knee takes place between the semilunars and the femur, the discs moving with the tibia; and that rotation occurs between the tibia and the discs, the latter moving with the femur.

The ligamentum mucosum is not a true ligament, but is the free upper border of the fold of synovial membrane which passes backwards to the anterior crucial ligament just below the patella. When the knee joint is opened above the patella, and the latter is turned forwards, two folds of synovial membrane are seen passing back on each side of the ligamentum mucosum. These are described in the text-books of anatomy as ligamenta alaria.

Tenney[1] has drawn our attention to the fact that the alar ligaments described by Morris and others cannot be found in joints hardened in formalin and from which the condyles of the femur have been removed subsequently; he states, however, that their apparent continuation as two fibrous folds of the extensor aponeurosis on each side of the patella can always be seen. Pauzat traced these fibres down to the anterior ends of the semilunar discs, so that their effect would be to pull the discs upwards and forwards when the quadriceps contract. Tenney could not confirm this observation but traced the fibres into the infrapatellar pad of fat, and he considers that they pull up the synovial membrane and infrapatellar pad of fat and prevent the synovial membrane covering this pad from being nipped between the bones—an accident referred to by Hoffa[2] and others, which frequently occurs when the quadriceps extensor is atrophic and weak.

The motions of the joint are anteroposterior gliding movements and rotation of tibia upon femur. The ligaments allow of no other movement. In no position of the knee is lateral movement allowed, but when flexion is partial considerable rotatory movement can take place, and every time the knee is fully extended a certain degree of outward rotation normally occurs. The ligaments which prevent side-to-side movement during extension and during slight flexion are the laterals, and during the more acute flexions the crucials. It is obvious, however, that in conditions of strain the muscles are valued accessories—the rectus in front and the hamstrings behind—but they are quite inefficient as substitutes for either the crucials or the lateral ligaments should they be put out of action.

Griffiths,[3] of Cambridge, who has written a thoughtful article on the mechanism of the knee, having severed the internal lateral ligament, found that during extension of the limb the tibia could be appreciably bent outwards and the articular surfaces of tibia and femur correspondingly separated. If the same joint were flexed the crucials prevented such movement. In a case of complete rupture of the internal lateral ligament in a wrestler, I confirmed this experiment clinically and in another patient, where a portion of bone accompanied the separation of the ligament, no lateral movement was permitted during acute flexion. A strain upon the ligament is much more severe when it is twisted as well as stretched. Now, how can such a twist be applied? It takes place when the knee is flexed, the foot abducted, and the femur rotated inward. It is, in fact, in this position that strain and rupture of the internal lateral ligament and displacement of the semilunar cartilage almost always occurs.

A study of the anatomy shows us that there is a very close association between injuries to the lateral ligaments and displacements of the semilunars. An important point to remember is that from the closer approximation of its ends the external cartilage is more movable than the internal, and this is made more pronounced by the laxity of the part of the capsule to which it is attached.

Experiments on the Cadaver.—Experiments on the cadaver show that extension of the knee is limited: First, by the posterior crucial ligament; second, by the anterior crucial ligament; third, by the internal lateral ligament; fourth, by the external lateral ligament, and that an increased range of movement is obtained as each structure is divided in succession.

External rotation of the leg is limited by the two lateral ligaments and is increased if either be ruptured or cut.

Internal rotation of the leg is limited by the internal lateral and anterior crucial ligaments.

In external rotation the tibia may slip forward slightly on the femur but is stopped by the anterior crucial ligament.

In internal rotation the tibia may slip back a little but is stopped by the posterior crucial ligament.

In the cadaver when the joint is extended and weight put on it the external semilunar cartilage can be made to fit closely to the condyle, but in no other position. The internal semilunar cannot be snugly fitted to the internal condyle in any position (Tenney).

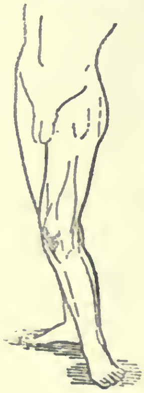
Function of the Semilunars.—The function of the semilunar cartilages is to assist the opposite lateral ligaments to resist lateral movements of the knee. It acts as a wedge between the tibia and femur and makes the crucial ligaments more tense.

When the leg was forcibly abducted on the cadaver, Tenney found that the internal lateral ligament tore away from its femoral attachments. The femur then slipped over the posterior end of the cartilage and when replaced crumpled up the posterior half of the internal semilunar. He points out that this is different from Hoffa's operative experience in which he found the anterior half of the cartilage curled up.

Clinically, it is the lower attachment of the ligament which usually gives way; the semilunar is then drawn back by the condyle, its anterior end gets worn and pinched between the bones.

We have seen that bending inwards of the knee in the extended and semi-extended position is prevented by the internal lateral ligament. Bending inwards of the knee during the fully flexed position is prevented by the crucial ligaments. These two anatomical facts should be remembered in their relation to displacement of the internal semilunar. One can thus easily understand how it is that the internal lateral ligament so frequently suffers injury. It is subjected to strain whenever the foot is firmly planted and abducted and the knee either slightly bent or kept extended (Fig. 5). If, in addition to this, as in the stroke to leg in cricket, or the final act of the bowler, body weight with rotation of the femur is added, we have produced that stretching and strain which Griffiths has proved to be so harmful to the integrity of the ligament. Indeed, the strength of the knee joint can be well gauged by the resisting power of the internal lateral ligament. Circumferentially, the internal cartilage is attached to the tibia by structures which allow the cartilage to be lifted fully a quarter of an inch—a point which is of importance. If the internal lateral ligament be torn above the level of the joint the cartilage remains upon the tibia; if torn below the level of the joint it follows the rotary movement of the femur. If the ligament be ruptured above and below the level

Fig. 5.



of the cartilage, it becomes a very simple matter to push it within the joint, a not unusual position to find it in. It would appear, therefore (Griffiths), that displacement or fracture of the cartilage can only take place when the internal lateral ligament is stretched or ruptured. This allows a separation of the joint surfaces and a slipping inwards of the cartilage; as the separate bones snap back the cartilage is nipped, and the knee is fixed in a very painful manner. The pain and effusion can be ascribed to injury to the synovial membrane, with which, as I have already stated, the cartilages are covered.

INJURY TO CARTILAGES.

In practically all cases the cartilage is displaced inwards, and in those rare cases where a protrusion has been felt from the outside it is due either to bruising and hemorrhage or to a buckling of the cartilage which gives an irregular feel to the articular margin. When we consider the wedge-shape of the discs, a displacement outwards could not possibly produce a locking of the joint; this can only occur when the displaced cartilage, acting as a foreign body, gets jammed between the bones. It is this internal displacement which gives rise to the acuteness and painfulness of the attack. We must all have been struck with the absence of anything abnormal from an external examination of a knee subject to recurrent attacks.

Now, what are the symptoms of displacement of the semilunars? The most constant symptom is a sudden inability fully to extend the joint; the cause of the displacement is strain thrown on the internal lateral ligament while the knee is flexed and the femur rotated inwards (Fig. 5). The force necessary in a first injury is generally great, the pain acute, and the victim, if an athlete, hobbles laboriously off the field with flexed knee. He is afforded a certain degree of relief by his friends in the pavilion, who fully flex his limb and then extend. When he reaches home the practitioner finds a distended knee, painful to manipulate. The strain which is most painful is that caused by stretching the structures on the inner side of the knee, and this is most acutely felt over the site of injury. In a certain proportion of cases, even with the knee fully extended, a gap between the bones on the inner side can be obtained by manipulation. For several succeeding days there will be pain on pressure over the articular edge of the tibia opposite the ligament, and, generally speaking, some pain between the bones on pressure to the inner side of the patella. In a fortnight or three weeks, and after rest and massage, the patient is by common consent allowed liberty to walk. As we shall see later, this liberty is a mistake and the outcome of very indifferent surgery. Days, weeks, or months may elapse when again a train of symptoms, similar in character, but generally milder in effect, occurs. Many successive attacks, some grave and followed by effusion, some so trivial as merely to incommode, mark retrogression. In nearly all cases there is a history of strain or injury, the initial displacement as a rule being the most severe, while in the constantly recurring case any eversion of the foot may give rise to the displacement. I have had occasion to operate but twenty-four times for an external semilunar, which in my personal work only represents a 7 per cent. proportion. The reason the internal cartilage is so frequently involved is dependent entirely on anatomical grounds. Being, as we have seen, more firmly fixed by ligamentous attachments than the external, there is not the give and take about it which is found in the less controlled external cartilage, especially in the rotatory movements of the joint. Again, in the normal relation of femur to tibia the line of force is carried through the inner side of the knee; this is further emphasized by the abducted position of the foot which, if exaggerated, produces outward rotation of the leg. Another reason may be found in the fact that owing to the shape of the internal articular surface of the tibia the internal condyle of the femur can glide backwards on the tibia; thus the range of internal rotation of the femur on the tibia, which is a direct strain on the semilunar, is greater than that of external rotation.

Out of 117 cases operated upon (1906, 1907, 1908) for injury to the cartilage in which a lesion of the disc was found—

53 were torn from their anterior attachment.
16 were split longitudinally.
8 were attached by the cornua and torn from the capsule.

7 were displacements of the posterior horns.
12 were fractured transversely opposite the internal lateral ligament.
8 were loosely bound circumferentially with no other appreciable abnormality.
8 had undergone changes in the loose anterior extremity of the semilunar of a nodular type, some being as lumpy and large as a pea.
3 cases exhibited no trace of the cartilage.
2 cases showed the anterior part doubled and adherent to the posterior part.

In the remaining cases it was difficult to classify the injuries; some cartilages were so friable as to tear when grasped with the forceps and others presented fringed edges.

Apart from slipping, the most constant symptom of injured semilunar, in over 400 cases operated upon where the lesion was present, was localized pain on pressing over the injured spot. This was felt for fully a month after injury. It is best elicited while the knee is flexed, when pressure between the bones can be more effectively made. Locking was found in less than half the cases. Effusion was present in nearly all cases after the primary injury, and lessened or disappeared in proportion to the ease and frequency with which further displacements occurred. In one case where operation was refused for a long time, and where the patient had for three or four years slipped his knee several times a week, barely any inconvenience was experienced beyond a sort of rocking in the joint. He had no effusion, and consented to be operated upon only because he was going abroad on a sporting expedition. The anterior part of the internal semilunar was fractured and displaced into the intercondyloid notch, while the external cartilage was detached in front. In other cases where the symptoms were often acute, barely any lesion except a looseness of the moorings could be found. In five cases where the symptoms—generally historical—pointed to injury of the external cartilage, the lesion was found on the inner side. In two cases operated upon since 1908, the internal cartilage was found on the outer side of the joint.

As mentioned, during the years 1906–1908, I found 117 demonstrable lesions of the semilunar cartilages. During those years, however, I opened 190 joints with symptoms of derangement. In 30 I found thickening and irregularity of the structures about the ligamenta alaria. I found 9 cases of pedunculated fringes of a polypoid appearance. In 10 cases, I could find no lesion after careful search; in 3 of these cases—to be referred to later—I found on subsequent operation that the symptoms were due to the behavior of a tendon over an osteoma, and in 1 to a small fracture irregularity on the femoral condyle. In 8 cases the starting signs of hypertrophic arthritis were present; in 9 cases there were isolated loose bodies, and in 4 cases, loose bodies attached by pedicle to the synovial reflection. The remainder presented villous arthritis along the articular margin, lipoma arborescens and fibrous thickenings around the attachment of the anterior crucial ligament. In 20 of these additional 73 cases I expected to find injured semilunars, but was mistaken.

Many of the cartilages which I have removed at various periods had undergone changes which rendered them barely recognizable,—some were nodular and fibrous, some thin and frayed and some adherent to that part of the tibia on which they lay. The loose bodies are very interesting. They may be cartilaginous, bony, fibrous or fatty. When fibrous, they usually result from unabsorbed blood clot. The lipomata may be small or large, and develop in the synovial tissue, being attached usually by a pedicle. The larger lipomata are usually found to the side of the ligamentum patellæ. Hypertrophy of the synovial villi is frequently confused with a damaged semilunar. The condition is much more common than is usually expected, and I have frequently met with it in exploring joints. It is usually primarily the result of synovitis,—frequently later, the cause of it. The whole joint may become papillomatous, or a few isolated fringes may be found generally where the synovial membrane meets the cartilage. They are often pedunculated, may be found anywhere along the articular margin, and are composed of fibrous tissue, fat and blood-vessels. In spite of the difficulty of an accurate diagnosis, effort should be made to differentiate.

Differential Diagnosis.—Injury of the internal semilunar is diagnosed by the acuteness of its onset, by the persistence of pain on pressure over the detached or injured area, by tenderness less pronounced over the inner side of the patella, and by a locking of the joint. The patient usually refers the pain to the front of the joint until pressure decides it for him. Irregularity is sometimes found along the articular margin and often a sense of discomfort when the tibia is abducted and rotated outwards, even when the toe lightly touches an obstacle. The history of the mode of production is helpful.

Injury to the external cartilage produces a similar train of symptoms occurring on the outer side of the knee.

Synovial Fringes.—The symptoms of the nipping of a synovial fringe are less acute in its primary occurrence than are those of a displaced cartilage. The pain is strictly local and is not participated in by the internal lateral ligament. Frequently a prominence may be found over the site of pain, and no matter how often the nipping occurs effusion follows, creaking in the joint is a frequent accompaniment, and often an obvious swelling occurs on each side of the ligamentum patellæ (due to the chronic thickening of the infrapatellar pad).

Loose Bodies.—Loose bodies can usually be found and isolated by the patient. They often lock the knee but only transitorily. The symptoms are sharp but not acute, and unless pedunculated they may be referred to different places. Effusions are common.

Lipomata will sometimes lock the joint. There is often swelling about the lower part of the patella and painless effusions. Exercise rather than accident produces the symptoms which are rarely acute, and pressure on the knee will produce no pain.

Osteomata can be found by manipulation and by radiography. They sometimes lock the joint when a muscle or tendon becomes entangled. Such cases I shall briefly relate.

Rupture of the crucials, of which I shall relate cases, is the accompaniment of so severe an injury that other structures participate in the general strain. The tibia can be made to glide in a to-and-fro direction, and when the knee is flexed lateral movements are free. If the lateral ligaments are torn, lateral movements in the extended position are also free.

I am quite conscious that despite any amount of care in diagnosis, error is inevitable in a number of cases, and only exploration can give us accurate information. For some weird reason, on occasions all the symptoms may point to injury on the inner side and when an exploration is made no lesion can be found. One such case I shall relate.

CASE I.—A young man of firm muscular development received an injury in a football scrimmage. His knee locked and he was laid up in bed for three weeks. He complained of pain, as far he could recollect, both on the inside and on the outside of the patella. Five weeks later, when jumping over a ditch, his knee locked, but only very transitorily and he was able to reduce it. He complained of pain on the inner side of the joint over the lateral ligament. On three subsequent occasions something gave on the inner side of the knee, and when he consulted me, some weeks after his last attack, all tenderness had gone. I decided that the internal cartilage required removal, but when I explored it I quite failed to find any defect in its appearance or behavior. I examined for loose bodies or hypertrophied fringes, but quite without success. Thinking that perhaps a loose body might be found on the outer side, I explored that aspect of the articulation through a second incision. To my great astonishment, instead of a loose body I found that the posterior horn of the external cartilage was doubled over and displaced forwards. Complete removal of this cartilage resulted in recovery.

CASE II.—I shall relate another case to show how a displaced cartilage may not give rise to any typical symptoms. I saw a boy of 18 who periodically had effusions in his knee, accompanied by much creaking but no pain. Three years previously he fell, but gave no history of locking, and walked a mile home. Next day his knee was much swollen and for a fortnight he rested it. For three years this effusion continued, with short intervals. The knee felt stiff; it sometimes pained when fully extended, but never once did he feel anything give in the joint, nor was pain ever referred to any localized spot. Every variety of treatment had been tried and discarded before I saw him—rest, splints, massage, exercises, electric baths—but all of no avail. I determined to evacuate the joint by lateral incisions, and if necessary inject the cavity with iodine and alcohol. On entering the articulation and peering around, I saw the anterior end of the internal cartilage thinned and detached and lying very flat to the inner side of the anterior crucial ligament. I removed the cartilage and evacuated the contents of the joint. Movement and massage were started in a fortnight, and the patient made a slow but uninterrupted recovery.

I mention these two cases as being of considerable clinical interest in order to emphasize difficulties of accurate diagnosis. It must not be thought, however, because of these very exceptional cases, that it is useless to attempt classification. On the contrary, the case where a diagnosis is difficult or impossible is the exceptional case.

The most common injury to the knee joint is a sprain or rupture of the internal lateral ligament. As we have seen, this should not be mistaken for a slipped cartilage. In the one case a derangement is experienced, in the other it is never so. Next to the injury of the internal lateral ligament—which is often commonly called a sprained knee—injury to the inner cartilage is most frequent, and the problem of treatment must be solved. I maintain that a great distinction should be made between a primary and a recurrent luxation. I never operate in any but recurrent cases, and I have no doubt that were the first offence intelligently dealt with and at once, the proportion of such recurrence would be materially diminished. This may not be quite orthodox, but I cannot help feeling that it is quite true. Surgeons point to the thinned and battered cartilage, fractured here, displaced there and ask, "What can mechanism do here?" It is quite true! A time comes when operative measures are inevitable, but that is only when cartilages inefficiently reduced or far too frequently nipped, show the evidences of their maltreatment. The first displacement will not be accompanied by any degenerative change, and the knee will very often quite recover if appropriately approached. (*a*) Reduction must be absolute. (*b*) All movement of the cartilage must be checked until union of the torn structures is complete. (*c*) No lateral strain must be allowed until the torn or stretched internal lateral ligament has recovered its tone and strength.

With regard to reduction it does not matter what method is employed provided easy full extension is secured. Too often, more especially in badly displaced or protracted locking, the surgeon is content to acutely flex and extend the joint, and if at last, though full extension is not quite free, a back splint is applied and extension (which should be secured by manipulation) is brought about by pad and bandage, what probably happens is this: Reduction not being quite complete, there remains a slight obstruction to full extension, and the pad and bandage tightly compress the cartilage between the bones. Let us remember as we would an axiom, that we can only be assured of reduction when the knee can voluntarily be held in complete extension. It has been authoritatively stated that extension of the knee is often not possible because of bruising of the cartilage.[4] I would venture to insist on a reduction in every recent case of which easy extension is alone the proof. I learned this lesson some years ago. A youth, subject several times before to slipping in his knee, came to me straight to the pavilion from the cricket field. His joint was locked at an angle of 40 degrees. I put the limb through the orthodox manipulation, and it came nearly straight. I tried again with a similar result, and felt inclined to be content. "It is not in," he said, and, humiliated, I strove in public for five minutes, when, without any objective sign he cried, "Now I am right," and the knee could forthwith be held extended.

In reading text-books one would conclude that the reduction of a displaced semilunar is the easiest possible routine. This is a deduction based on very limited experience, for some cases are specially difficult to reduce. In the majority of instances, reduction is easily effected; in a few recent cases it is difficult; in some old cases it is extremely troublesome. What is the best routine manipulation? Acute flexion, lateral deviation and rotation inwards and full extension. Acute flexion is always painful, but it is the only position where internal rotation of the tibia is most free; lateral deviation separates the bones which hold the cartilage, and full extension allows of readjustment and places the limb in such a position as to permit of accurate union of the internal lateral ligament.

Retention of the Cartilage in a Fixed Position.—This can only be secured when the limb is fully extended. In all rotary and lateral movements of the joint the cartilages participate. It follows, therefore, that both these movements should be prevented if we are to strive for accurate union of the torn attachment to the cartilage. Rest of the limb in a fully extended position is therefore indicated, and rest should be accomplished in bed so long as effusion lasts. Do not let us forget that a joint distended with fluid relaxes by elongation of all the protective soft structures of the joint, and the more rapidly we attain absorption the more we avoid a prolonged weakness. When all fluid is absorbed and the knee resumes its normal aspect, we proceed to the next stage. It may be days, it may be weeks; if slow, massage may help, but under no conditions must flexion be allowed. Flexion, as we have seen from the anatomical conditions, interferes with the moorings of the cartilage and the integrity of the lateral ligaments, both disturbances quite inimical to union of the torn structures. The third indication is to prevent for a prolonged period lateral deviation of the joint. We have seen that in derangements of the cartilage strain or rupture of the internal lateral ligament is a necessary incident; it follows, therefore, that during recovery no lateral strain should be thrown upon the knee.

Sir William Bennett [4] and Mr. Whitelocke [5] in their interesting monographs differ from me in my conclusions regarding the prevention of lateral strain. Although the latter author agrees that early rest, " from theoretical considerations . . . would seem only reasonable and common sense," he adds, " that the cases treated by shorter methods and with movements from the first are to say the least no more liable to recurrence." In my opinion, a short splint, devised merely to prevent flexion and lateral deviation for the first few weeks, offers the only logical hope of recovery to the injured structures. Afterwards massage and exercises can be assiduously employed.

One of the simplest methods of preventing strain upon the internal lateral ligament is to walk upon an inverted foot with inturned toes. Seeing, as I do, a great number of cases of rickets, I am in the habit (when treating a genu valgum in an early stage) of insisting that the patient should walk with parallel feet, so aided by altered boots that the body weight is deviated from the inside to the outside of the tarsus. This throws a slight strain upon the external lateral ligament, and enforces pressure upon the inner articular surfaces of tibia and femur. So effective is this pressure that it generally suffices in a few months to correct the deformity. You can understand, therefore, what an important ally we have in so simple a measure to relieve the injured internal lateral ligament from strain.

In cases where the cartilage becomes displaced at frequent intervals I order an alteration in the heel and sole of the boots. The heel is elongated and raised on its inner side, and the inner side of the sole is fortified by a small wedge of leather. When the patient stands in such a boot the foot is inverted, and the lateral strain which is needed to displace the cartilage is avoided. If, in addition to this, the young athlete be told to walk with an inturned toe, and to run pigeon-toed, strain is inevitably thrown upon the external lateral ligament, while the internal lateral ligament is protected. Although immunity from displacement cannot be assured by this device, it materially lessens the tendency to its occurrence and becomes a valuable asset amongst our remedies. In addition, a splint must be employed.

In those cases where operation is not advised, or is rejected, a splint is indicated, so devised as to prevent lateral strain upon the knee, and to allow free movement. In all recurrent cases which do not need operation, and in all cases of first displacement sufficiently recovered for flexion to be allowed, one orders a splint, alters the boot for the purpose of inverting the foot, and disallows walking except with parallel feet and running except with inturned toes. In addition to this, the quadriceps, as the guardian muscle of the knee, must be energetically massaged and otherwise kept fit and strong. May I once again emphasize the importance of adequately treating the first displacement, and of insisting that if the treatment is conducted on the lines I mention quite a large proportion of cases will make excellent and permanent recovery. The recovery depends upon complete reduction and uninterrupted union and consolidation of both the internal lateral ligament and the ligamentous moorings of the cartilage. In operating, as we so often do, on old injured cartilages, we are apt to be unduly biased when we see their thinned and battered edges. This condition can only be the result of frequent injury, and should not discourage us in the mechanical management of a first slip. I have at the present time many athletes playing tennis, football and cricket who have undergone a rigid mechanical treatment for undoubted displacement.

The question will be naturally asked: "What are the indications for operation?" I shall try to define my attitude in regard to mechanical and operative treatment.

In the first place, I *refuse to operate* in any case I see early, the subject of a first derangement. I *discourage operation* in those recurrent cases where the symptoms are transient and not followed by irritation of the joint. I *strongly urge operation* in those cases where a recurrent displacement is at times followed by acute symptoms. I advise it in all recurrent cases where a strenuous athletic life is a means of livelihood or a physical necessity. I think operation absolutely imperative in the case of men who work or stand in dangerous places and where a yielding of the knee may lead to serious consequences. Practically age has no influence over me if the indications I mention are present. I have operated upon a boy of fifteen and a woman of fifty-four.

Is there any danger apart from periodic trouble in a slipping semilunar? I can clinically support Mr. Arbuthnot Lane[6] when he says it may prove the exciting cause of tubercle. Frequently I have examined patients with tubercular knees and patients with rheumatoid arthritis whose early history was associated with internal derangements of the knees and in several cases of badly recurring injuries I have found sometimes congestion and sometimes erosion of the bone and cartilage upon which they rested. One case to which I shall refer bears upon the point.

Case III.—Some eight years ago, a youth, aged 19 years, consulted me concerning a cartilage which two years previously became detached. Several recurrences took place, some of them followed by synovitis and enforced rest in bed. I urged removal of the cartilage. The youth, however, persistently refused my overtures and only grudgingly and spasmodically wore the splint. In less than eighteen months I noticed that one of the attacks left him with a thickened and sensitive knee, which in time refused gradually to extend fully. At the present time he has recovered from a typical tubercular knee, firmly ankylosed.

This case is specially interesting to me as I have been able to watch the development from the beginning. Another case, a man aged twenty-five years, a boilermaker, sprained his knee. Later he became a frequent patient, with slipping internal semilunar. Three years after, creaking and swelling of the joint led to the suspicion of the hypertrophic variety of rheumatoid arthritis, which radiography fully confirmed. Of two cases, carefully watched, each refusing operation, one resulted in rheumatoid and the other in tubercular change. I would suggest, therefore, that this danger should be kept well in view, and that patients with either a tubercular or rheumatoid diathesis subject to recurring derangement should early be persuaded to have the exciting cause removed.

Is operative treatment invariably successful? In the great majority of cases a perfect recovery may be predicted; in a certain small percentage of cases the symptoms recur. The recurrences were far more numerous some few years back, when the cartilages were sewn to the tibial attachments. The same causes which accounted for the initial displacements produced the recurrence. Since it is customary to exsect the cartilage other causes than a displacement must be searched for in answer to symptoms. It will then be discovered that the so-called recurrence is due to an overlooked accessory factor in the production of the symptoms of derangement. I shall illustrate this by very briefly referring to cases.

Case IV.—A young woman of 24 complained of a locking which was referred to the outside of her joint. It had recurred on several occasions, was sometimes accompanied by pain and sometimes followed by effusion. On occasions the slipping was not accompanied by locking. On opening her knee joint the external semilunar was found torn anteriorly, and I removed the anterior half. A month did not elapse before slipping again occurred, and on careful enquiry as to locality no reliable history could be obtained. I therefore opened the knee from the inner aspect, as I felt I should have seen any abnormality had it been present on the other side at my first operation. Floating by a thin pedicle a small fibrous nodule presented, which was removed with scissors, and the knee soon recovered its normal function.

Case V.—A miner of about 30 complained of a slipping in his joint, sometimes accompanied by locking. There was always sensitiveness over the articular border, between the patella and the internal lateral ligament. There was often effusion. On opening the joint I found the anterior portion of the semilunar abnormally free, but apparently not detached. Having several times found a similar condition, for which I exsected the cartilage with restoration of normal functions, I exsected here, and for some months no symptoms were experienced. Later, however, quite similar symptoms were complained of, and pain, again referred to the inner side of the knee. I followed the line of the old scar and searched for a cause. I was almost closing the wound when internal rotation of the tibia dislodged a loose body which shot out of my wound.

Both these cases illustrate the danger that more than one mechanical defect may exist in a joint, and the removal of merely a part of them will not cure the patient. We must therefore carefully inspect a joint when it is opened, to make sure that we have attacked all those elements likely to give trouble.

Loose Bodies.—As early as 1803, according to William Hey, successful removal of these bodies was performed, but one learns from the account of Larrey[7] how dangerous an operation it was. In 1861 he collected 169 operations from the time of Ambrose Paré for simple removal of these bodies, 131 by direct and 38 by indirect or subcutaneous incision. By the direct method 99 were cured—several with ankylosis, 5 failed and 30 died. By the operation in two stages 19 were cured, 15 failed and 5 died.

I have already referred to the similarity in symptoms between these cases and injured cartilages, and suggested points for differentiation.

One has met quite a large variety of loose bodies in joints, some derived from organic changes, sometimes in connection with the hypertrophic type of osteoarthritis, sometimes due to detachment of cartilaginous or bony structure, others introduced from without. For quite a long time a young woman puzzled all whom she consulted, for intermittent effusions, locking of the joint but hardly any local tenderness on pressure. She often walked a mile with barely appreciable discomfort. When we X-rayed her knee (Fig. 6) it was found to be full of needles, which I removed by a large flap incision. The patient, who was a wilful neurotic, delighted in surreptitiously introducing needles into her joints. She is now quite recovered and doing hard work.

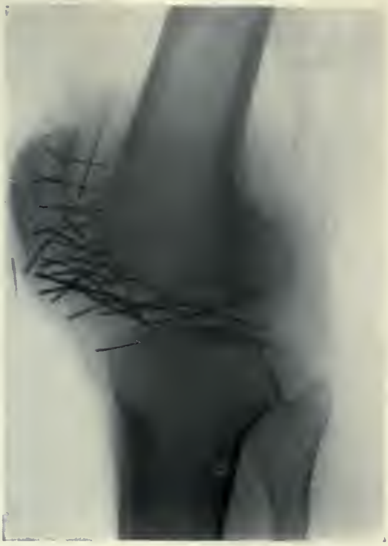
The treatment of loose bodies of whatever kind is their removal. It is quite true that they sometimes become fixed in a harmless place, but it is hardly worth our while to wait for this. If the body can be localized and fixed this is a very simple matter, and the operation will be described later. If it cannot be localized it is probably pedunculated, and the surgeon generally finds it when the operation has been performed in the expectation of finding slipping semilunar—indeed, the symptoms are identical. In such a case it will nearly always be evident, even by the small incision we make for a semilunar. Often large numbers of bodies pour out of the wound, some as small as millet seeds and others quite large and irregular.

DERANGEMENTS OF THE KNEE DUE TO EXOSTOSES.—I have many times operated upon joints that became locked or obstructed by the slipping of muscle or tendon over exostoses.

In one instance (Fig. 7) an athlete on several occasions was suddenly pulled up while running, with a pain at the upper part of his popliteal space with sometimes considerable swelling. An X-ray revealed a pedunculated exostosis which occasionally obstructed the vastus. It was surrounded by a bursa, inflamed and containing fibrous masses.

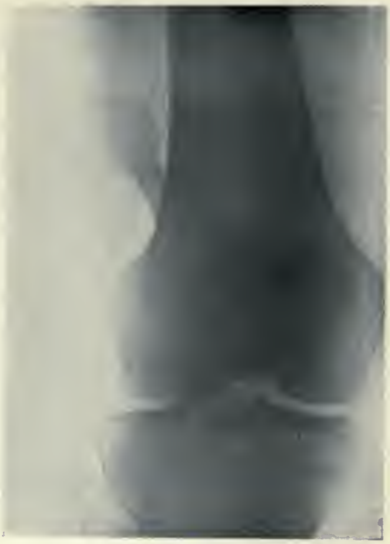
Fig. 8 is a type of one of four cases and will serve as a clinical picture of the rest. The patient, a youth, comes with the history of a knee which slips at the back. It nearly always occurs when active or unusual exercise is being performed. The knee sometimes completely locks, and in such a case is often difficult to reduce. Generally, however, it is as one would expect a sense of discomfort and slight slipping which prevents whole-hearted athleticism, and frequently the patient falls, gets up again, feels the back of his knee and off again he runs. Sometimes it is the biceps which is hampered, at other times the inner hamstrings, and in one instance I removed a pedunculated exostosis which constantly became entangled with the outer head of the gastrocnemius. Fig. 9 shows an osteoma which ceased to trouble when it fractured. The fracture never united and the osteoma is now considerably reduced in size. Fig. 10 shows a flattened osteoma which gave rise to symptoms suggestive of inner semilunar, really due to its contact with the sartorius and semitendinosus, and the osteoma shown in Fig. 11 also obstructed tendons. More rarely symptoms may arise from sharp exostoses over the adductor tubercle, as shown in Fig 12. Usually there

Fig. 6.



Knee joint filled with needles.

Fig. 7.



Exostosis of femur near the knee joint.

Fig. 8.

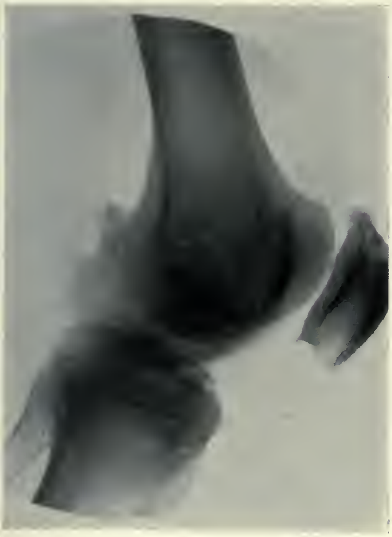
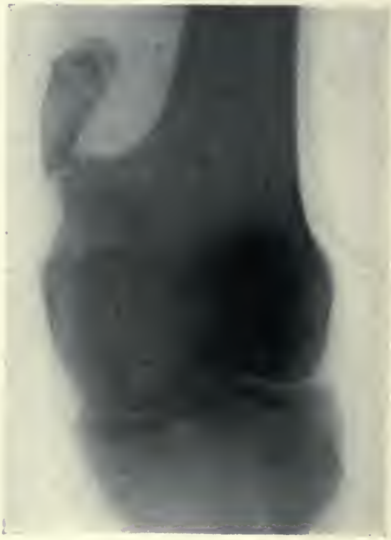
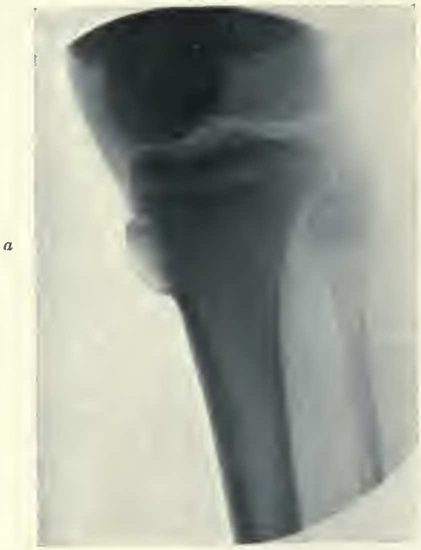


Fig. 9.



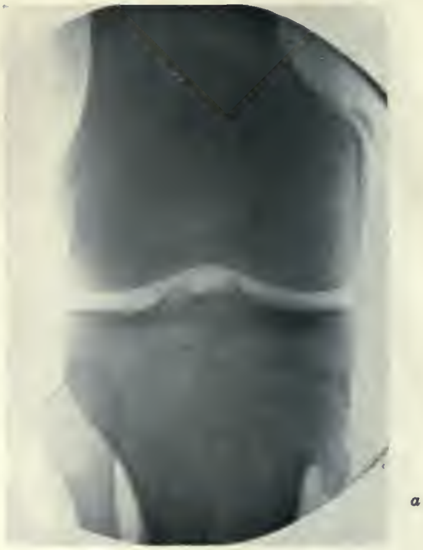
Osteoma which fractured and then ceased to give trouble.

Fig. 10.



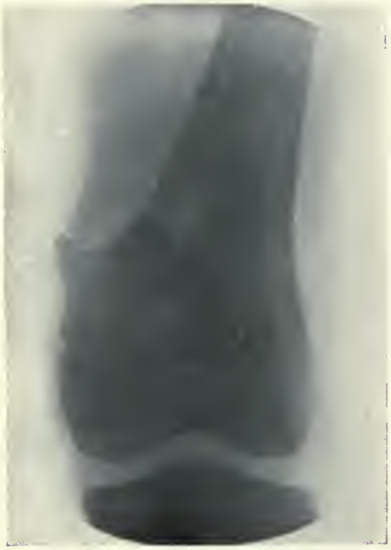
Exostosis of tibia near the knee joint.

Fig. 11.



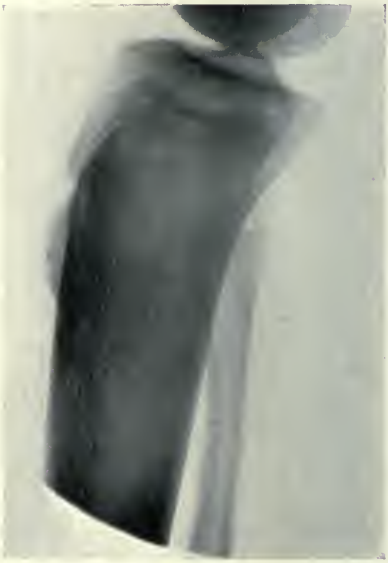
Exostosis of tibia near the knee joint.

Fig. 12.



Exostosis from the adductor tubercle of the femur.

Fig. 13.



Exostosis of tibia involving the quadriceps tendon.

should be no difficulty in making a diagnosis in these cases, more especially if an X-ray photograph be available. The fact is, however, that osteomata are not associated with knee derangements because they so often exist giving rise to no symptoms. Fig. 23 shows a most interesting osteoma which constantly became involved in the fibres of the quadriceps. Removal of these masses should be performed even in the growing epiphysis if they give rise to symptoms, and care should be taken to make the removal complete.

THE SNAPPING OR CLICKING KNEE.—A condition very puzzling, but one which most have probably encountered, is a loud click on acute flexion and sometimes on complete extension. This condition has been described as "trigger knee," because of its characteristic snap. It is most frequently experienced when extension is all but complete. You place your hand upon the patient's knee and ask him to extend his joint; this he does almost perfectly until about 170 degrees, when the remaining distance is performed suddenly accompanied by a click and usually an outward rotation of the tibia. The cause is difficult to explain and is generally ascribed to a disturbance of the movement of the external semilunar, which is successively caught and freed between the joints. Two cases I operated upon may throw some light upon what the surgeon may sometimes expect to find.

CASE VI.—A bank clerk not given to athletic sports presented such a knee. He complained of a sense of insecurity, more, he said, imaginary than real, and he told me that his health was undermined because of the nervous irritation it caused. The click, though most uncomfortable, was not accompanied by pain and never by effusion. He refused the suggestion of mechanical treatment, and I explored his joint. I was desirous of not opening his joint by a large anterior flap, and without any real reason I entered it from the inner instead of from the outer side. At once the cause was apparent. Tapering from the anterior portion of the cartilage and attached by a cartilaginous pedicle was a chrondrous structure the size and shape of a flattened pea. It lay loose just on the inner side of the anterior crucial ligament, not so far back as the spine. On extending the joint the click was heard, but I could not, of course, see exactly what occurred. I removed the anterior portion of the cartilage, the tadpole ending, and I was able at once fully to extend the knee without the occurrence of the sound. There was a distinct wearing of the cartilage over the short track traversed by this nodule. The patient made a complete recovery. My second case very closely resembled the first. Clicking on extension of the joint was constant but not complained of. Periodically, however, the joint locked, and it was for this reason I was consulted. The locking was on the inner side, and I therefore approached the joint from this aspect. The anterior portion of the cartilage was thin and cordlike, quite detached and ended in a thickened extremity On removal of the cartilage, the clicking disappeared, and the patient also recovered the proper function of his joint.

I shall be very interested in future cases where this puzzling symptom is present. The mechanical treatment of such a condition consists in the application of a splint which, while allowing movement of the knee, prevents its full extension.

Some years ago I operated on two cases, where a clicking could be felt at the back of the knee. In both instances it was due to the slipping of the semimembranosus tendon over a small tibial exostosis. In both cases the disability was frequent but not constant, and at times weakness and soreness were present.

A third case was both interesting and instructive. A man, æt. 24 years, complained periodically of a locking knee. The locking was accompanied by scarcely any pain, and it seemed to take place in the popliteal space, never in front of the joint. Generally there was no great difficulty in releasing the leg; the patient by very rapidly flexing the limb at once freed it. On occasions, however, the locking was very complete, and the knee would remain flexed for some time until medical aid arrived. An exostosis could be felt just above the insertion of the biceps tendon, which when removed was found to be bicornate, like the letter Y, and the tendon sometimes slipped over the whole of it and at others was received between the horns. In each of these cases, removal of the exostosis remedied the defect.

FRINGES AND INFRAPATELLAR PADS OF FAT.

In 1906 to 1908 inclusive I operated upon 51 cases which would come under this division, in which I do not count early cases of rheumatoid arthritis. In 30 cases the condition was directly associated with the infrapatellar pads, and in none did I discover any connection with the suprapatellar pads. The condition has been described by several writers, including Hoffa [2] and Tenney.[8] The latter writer refers to two types—one occurs in the case of very fat folk where the thickening is due to the same causes as the general lipomatous condition. In this type the intra-articular masses shrink as the fat is absorbed in other parts of the body. In the second type the disability is associated with the young and athletic.

My experience of the condition is of long standing, and I will relate a case which will serve as an example.

Case VII.—A young footballer lost his place in his team because of recurrent effusions after hard games. On the first two occasions the initial symptoms simulated dislocation of the semilunar without locking, but often no derangement could be noted and effusions were present without a knowledge of injury. At times he experienced a feeling of weakness in the quadriceps, which sometimes allowed him to fall when running down hill and restrained him from doing his best work. I saw him twice with the effusion and once during the recovered stage. At no time was pain complained of over the lateral ligaments nor tenderness over the articular margin, symptoms which are so characteristic of semilunar trouble. On pressing upon the patella while the knee was fully flexed and continuing the pressure during the act of extension a sense of discomfort hardly amounting to pain resulted. There was a marked thickening on each side of the patella. The recurrent effusions, the nodular firm swelling at the sides of the patella with the occasional yielding referred to the quadriceps suggested changes in the infrapatellar pads of fat. An operation revealed this condition and with a long curved scissors the pad was removed, when several small tabs compressed at their extremities revealed the mechanism of the lesion.

Fibrous hardening of the mass and the presence within it of traces of old hemorrhage were found on making a section of the fatty mass removed.

The patient was later able to resume first-class football without discomfort or sense of weakness.

This case is typical of most of the others excepting that in some cases where the tabs are elongated, more pronounced symptoms of derangement predominate over those of synovial irritation. In most of my cases the pad presented remnants of old hemorrhages, doubtless the records of separate previous injuries.

Frequently one finds in connection with this condition an œdematous fibrous state of the synovial membrane, especially in the pouches, and it may be necessary to enlarge the incisions to remove the masses in the same way as one removes the pads. An X-ray photograph will often reveal the fibrous changes in the intrapatellar pads and also the semilunars (Figs. 26, 27, 28).

RUPTURE OF ONE OR BOTH CRUCIAL LIGAMENTS.

This is a very serious accident, and one includes the old ununited rupture amongst derangements because it involves the joint in abnormal movement. When one considers the excellent recovery which sometimes follows a complete dislocation of the knee, one realizes that recovery of useful union of the crucials should be expected. Some years ago I was called to the country to amputate a gangrenous limb resulting from an unreduced backward dislocation of the femur. On opening the joint afterwards complete rupture of the crucials was displayed. I have had under my observation several cases of dislocation of the knee. It is usually a forward displacement of the tibia due to forcible hyperextension. Several cases exhibited the opposite deformity, in some the head of the tibia lay behind and above the articular line of the femoral condyles. I have met with one case of lateral displacement of the knee, unaccompanied by fracture. My recollection of most of these cases is that useful recoveries resulted although rupture of the crucials must have occurred in all. At times, however, where union of the ligaments has not resulted an operation may be needed. Such cases have been reported by Mayo, Robson,[9] Battle [10] and by me.[11]

Robson's case is interesting, being the case of a miner who met with a severe accident in 1902, being buried in earth, and sustaining, amongst other injuries, a fracture of the leg and of ribs. After many weeks in a country hospital he was admitted into the Leeds Infirmary with a swollen knee. When the muscles were braced up the bones were in good position, but as soon as the muscles were relaxed the tibia fell back until stopped by the ligament of the patella. By manipulation the head of the tibia could be brought forward in front of the femur, and there was also free lateral movement. It was decided that not only were the ligaments generally relaxed, but that the crucials had been ruptured. When operated upon both crucials were found completely torn from their upper attachments, the ends being somewhat shreddy. They were stitched in position by means of catgut ligatures, and some years afterwards when examined, the joint had almost wholly recovered its function.

Although I have seen several cases where the diagnosis of rupture of the crucials, either anterior or posterior, was suggested; I have had an opportunity of operating upon only one case.

Case VIII.—A barman fell down some cellar steps and dislocated his knee and for three weeks was kept at rest. He was then allowed to move about the house, and consulted me some ten weeks later. He had some pain in the knee, a little effusion, and, as he described it, " no dependence " on the joint. It slipped about, creaked, and was only moderately useful, and that only when a splint was worn. On examining the knee, the leg could be rotated inwards, but not outwards. The patient complained of pain whenever the knee was hyperextended, this being possible to a very limited extent. The tibia could be slightly displaced forwards in extension. I opened the joint by a free anterior incision, dividing the patella ligament, and found a complete rupture of the anterior crucial and considerable reddening of the synovial membrane. I freshened the ends, which were very frayed, and as they could not be brought together I plaited some chromicized gut as in nerve-union. For six weeks the patient was kept in bed, and in eight months after the operation the stability and mobility of the articulation was secured. In the early part of last year I examined a boy of 15 who fell in scaling railings and was caught by the foot and held head downwards. I detected a separation of a small piece of bone from the inner femoral condyle at the attachment of the internal lateral ligament, and there was free mobility in all directions. It was obvious that in addition to other lesions both the crucials were ruptured. Immobilization of the joint for two months and subsequent control of the lateral ligaments resulted in a good recovery.

We may, I think, conclude that rupture of the crucials is not an uncommon incident in dislocations of the tibia and other grave lesions, and that it is amenable to mechanical treatment if such treatment be sufficiently protracted. In old, neglected cases the gliding tibia is the characteristic derangement. If the anterior crucial alone be ruptured or elongated, the leg can be displaced anteriorly, it may be hyperextended, and it can be rotated inwards.

If the posterior or stronger ligament be similarly injured, the tibia can be displaced posteriorly. If both are ruptured, the tibia can be moved backwards and forwards, and if the knee be flexed outward rotation of the tibia is increased.

DERANGEMENTS DUE TO SMALL BONY SEPARATIONS.

On six occasions I have removed small portions of bone which have remained prominent after injuries to the femoral condyles. Three of these pieces were found lying in front of the anterior crucial firmly attached—two were attached to the internal condyle and one piece embedded in the centre of the infrapatellar pad (Fig. 14). I have frequently met with fracture of a small portion of the adductor tubercle and old standing ununited fracture of the tubercle of the tibia (Fig. 15), while of separation of part of the bony attachment of the internal lateral ligament both at its femoral and tibial extremities I have several radiographs. At times these pieces of bone give rise to derangement, more especially separations from the adductor tubercle. Removal is obviously the only treatment. In recent separation of the adductor tubercle, it is well to nail it in position. The same may be said of fracture of the tibial tubercle, which of course must not be confounded with Schlatter's disease, or partial separation at the epiphysis so common in boys. This fracture is sometimes followed by a thickening round about the insertion of the ligament (Fig. 13) painful to the touch. It is an osteitis which remains local and is most effectively treated by entering a chisel to the depth of half an inch.

FRACTURE OF THE SPINE OF TIBIA.

A rare and interesting derangement caused by fracture of the tibial spine came before me recently (Fig. 16).

Case IX.—A man of about 40 years was thrown off a bicycle six months previously. He was laid up with severe effusion and was not able to fully extend his knee. When he consulted me, three months later, walking was difficult and recurring effusion took place, although attempts had been made under anæsthesia to straighten the limb by means of manipulation, splint and bandage, but with no success. The knee remained unable to extend by about 15°. An X-ray (Fig. 16) showed a mass of bone in the centre of the joint.

On opening the knee by the incision which I adopt for semilunars I came down upon the tibial spine which was displaced backwards, carrying with it the anterior crucial ligament, but surrounded by a mass of fibrous tissue. I removed the bone, leaving enough adherent fibrous tissue to enable me to fix the anterior crucial. The result is a much stronger and more useful knee, which even yet cannot be fully extended. I have had no opportunity to search the literature for such an injury, but I cannot remember ever seeing a reference to it.

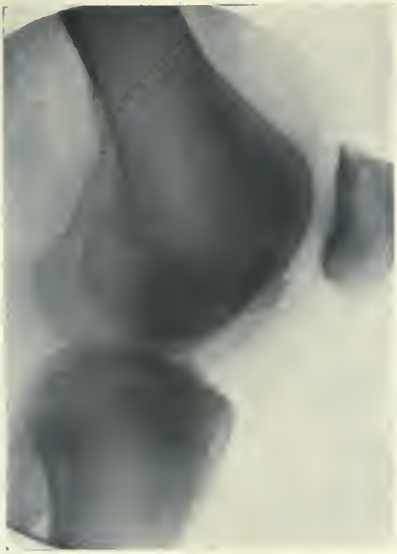
RECURRENT DISLOCATION OF THE PATELLA.

During the last two years I have operated upon twelve cases of this most troublesome affection which appears to the patient the most alarming of all derangements. Practically it always occurs on the outer side.

The etiology of the displacement is suggested by the anatomical fact that the line of action of the quadriceps in the axis of the thigh differs from that of the patella ligament in the axis of the leg (Fig. 17). When the leg is extended by contraction of the quadriceps the patella lying at the angle of the meeting of these two axes must be pulled outwards as the muscle and ligament attempt to form a sharp line. Indeed, there can be little doubt that displacement would be very frequent were it not for a second anatomical fact, viz. that the outer margin of the trochlear surface of the femur is so placed as to offer resistance to the outer deviation of the kneecap (Fig. 4 *b*). In a series of cases published by Goldthwaite [12] he drew attention to what I have frequently observed, that the tibial tubercle is displaced too much to the outer side, and in this way there is an increase in the angle of axis of the leg and thigh. If we alternately extend and relax the quadriceps, this lateral movement of the patella becomes obvious and we at once note the manner in which the trochlear surface of the femur checks displacement outward of the patella. As Goldthwaite well says, " If for any reason the line of pull becomes less direct or the articular ridge less perfectly formed; if the capsule be weakened by the distention following some acute injury; if the patella tendon be abnormally long, so that the patella is drawn above the outer edge of the trochlear surface of the femur; or if the joint can be hyperextended so that during the muscular pull the patella is lifted away from the femur—in any one of these conditions, the stability of the joint so far as the patella is concerned must be materially lessened."

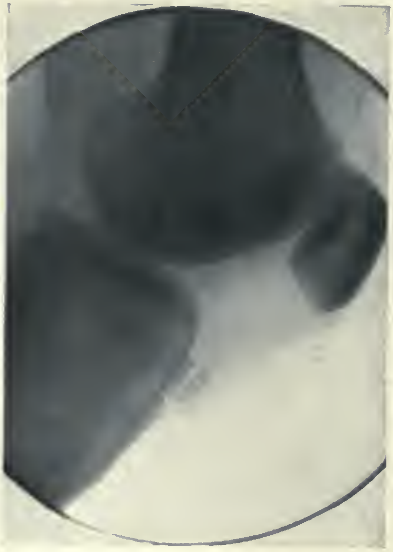
The symptoms of slipping patella are obvious and fairly constant. The patient, perhaps rising from a chair, feels an excruciating pain in the knee and often falls. He is unable to move. The patella is found usually on the outside of the joint; effusion of fluid follows. In the recurrent case, if of long duration, no pain accompanies the displacement and no fluid is secreted. The reduction is easily accomplished. The leg should be first extended, the inner edge of the patella be elevated and passed back to its place. Patients nearly always complain of weakness of the knees, and operative measures are sometimes needed to correct the disability. I have trans-

Fig. 14.



Spicule of bone separated from condyle of femur imbedded in the centre of the infrapatellar pad.

Fig. 15.

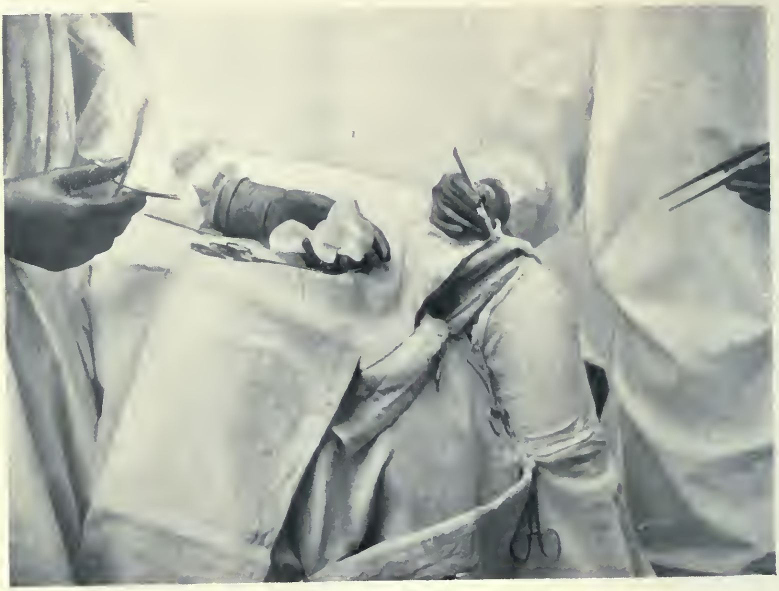


Old ununited fracture of the tubercle of the tibia.

Fig. 16.

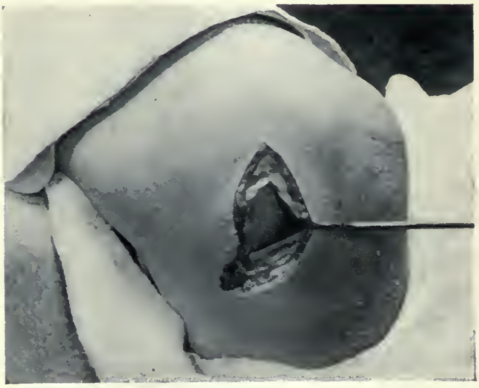
Fracture of the spine of the tibia.

Fig. 19.



Illustrating preparations for opening the knee joint.

Fig. 20.



Incision to expose internal semilunar, made with leg flexed to a right angle.

planted the tubercle of the tibia into such a position as to make the axis of the ligament and quadriceps one. In genu valgum accompanied by displacement of the patella I have performed a femoral osteotomy and maintained a strong extension in a small child. I have cut down upon the inner side of the capsule and seized it above and below by a pair of Kocher forceps. The forceps are simultaneously twisted and a longitudinal strip of capsule is plicated which draws the patella inwards; this plication is freshened and stitched without opening the joint. In one obstinate case complicated by genu valgum I divided the femur above the joint, transplanted the tibial tubercle to the inner side, and plicated the capsule. The best operation, however, in the uncomplicated case, is that

Fig. 17.

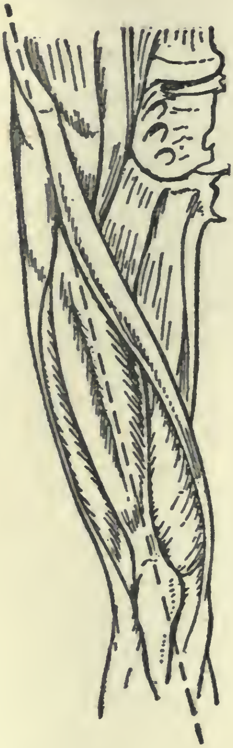
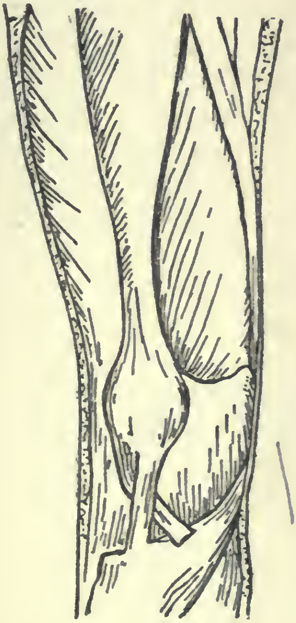


Fig. 18.



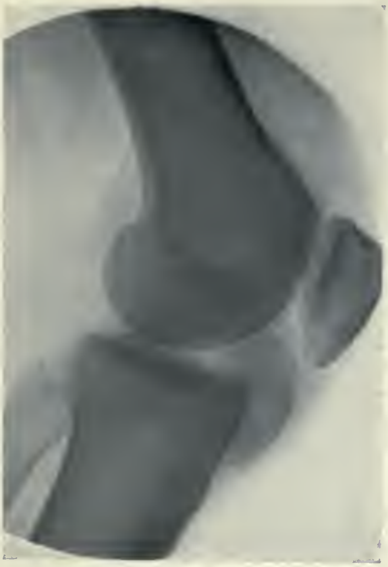
devised by Goldthwaite, who splits the patella tendon, and after detaching the outer half, passes it behind the remaining portion and implants it to the inside of the patella tendon. The tendon is stitched to periosteum and to the expansion of the tendon of the sartorius muscle (Fig. 18), and in addition I plicate the capsule on the inner side. The operative treatment should only be advised in the really troublesome case.

OPERATIVE TREATMENT OF SEMILUNARS.

As I have said elsewhere, there can be no greater tragedy in surgery than to infect a knee joint in operating for a derangement. In my early days I experienced one such tragedy which ended in death. Although since then I have opened the knee for mechanical derangement in considerably over 500 cases, I always approach the operation with the most rigid care. Obviously the greatest precautions should be taken whatever operation be performed on any part of the body, still, the slightest error in technic in removing irritant bodies from the knee will almost surely end in disaster. As Edmund Owen says, "the knee joint leaves no margin for mistake,"—in this respect it is so different to the abdomen. Before our precautions were as careful as they are, I had several cases, perhaps five or six, with reddened skin which caused anxiety but ended well. In others I operated for tense and painful effusion. In no case was there any serious trouble nor any loss of subsequent mobility.

Whoever undertakes to operate should be scrupulously clean; he should pay, not homage merely, to asepticism, but allegiance. I prefer to have the knee cleaned with soap and water night and morning for a full week and compresses of sterile water covered with mackintosh applied. On the evening before operation the knee is washed with ethereal soap followed by methylated ether, and is finally rubbed with biniodide of mercury, water and alcohol, 1 in 1000, dried with sterile wool, and a dry sterile dressing applied. On the operating table in the morning I conduct a final scrub with mercury and alcohol 1 in 500, quickly followed by a rinsing with sterile

FIG. 21.



Osteoma of tibia invading joint.

FIG. 23.

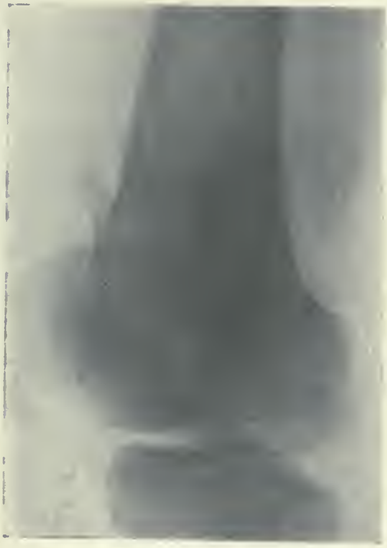
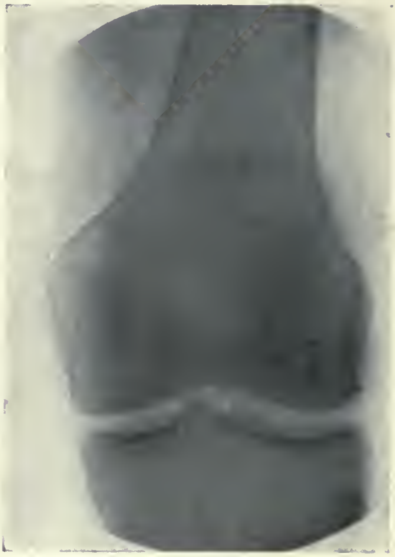
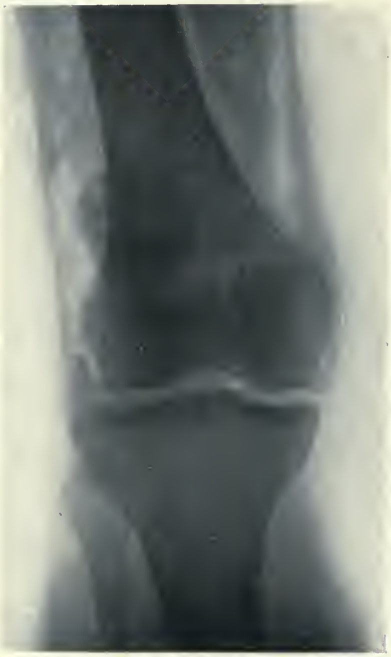


FIG. 24.



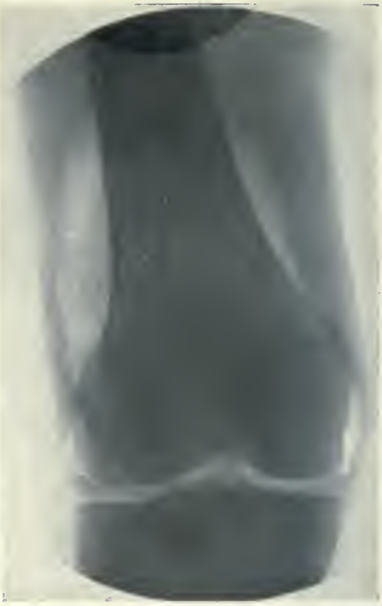
Detachment of bone with rupture of internal lateral ligament.

FIG. 25.



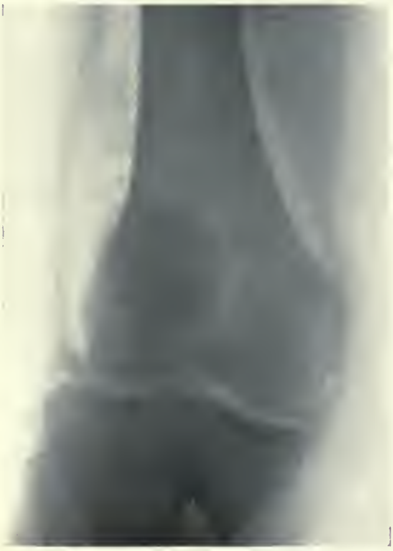
Detachment of portion of articular surface of femur, locking joint at angle of 45 degrees.

FIG. 26.



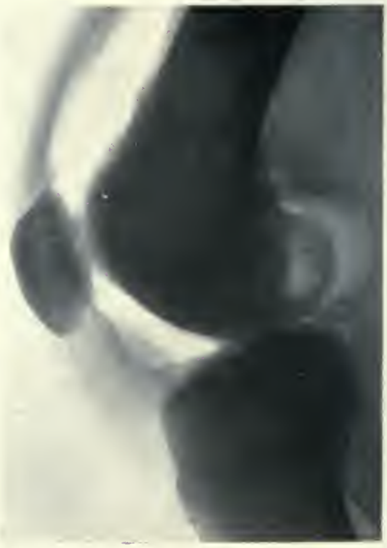
Knee distended with oxygen to show semilunar cartilages.

FIG. 27.



Joints distended with oxygen showing semilunars.

FIG. 28.



Joint distended with oxygen to show thickened infrapatellar pad.

water. The nurse, if she has to do with the sterilization of the knee, should be herself free from infected hands. She should not have touched a doubtful case for days. Both when the knee is washed and at a later stage, when chemically sterilized, the nurse must wear india-rubber gloves, boiled for each occasion; less than this is not enough. The surgeon's hands should be thoroughly prepared, first in running water and then with spirit lotion. Ten minutes at least should be spent in the rougher cleansing before a germicide is used. When the hands are as clean as water and lotion can make them, the antiseptic conscience will still distrust, and the surgeon must make assurance doubly sure by wearing boiled rubber gloves. Every one in the theatre should have head and mouth well covered, and a sterile gauze screen should be placed between the patient's face and the field of operation.

For some time I have given over operating with the knee in such a position that it has to be further flexed during the proceedings. Unless the greatest care is taken, the cloths get shifted or air is introduced into the joint. All surgeons of experience will have noted this. To avoid this risk I begin the operation with the patient's knee hanging at right angles over the foot of the table (Figs. 19, 20). To shift during the operation is to change the plane of the incision. The final cleaning of the knee takes place while the joint is flexed and the skin tense. Some thicknesses of sterile gauze squeezed out of 1 to 1000 biniodide of mercury is wrapped round the joint and the incision is made through the gauze, the cut edges of which are fixed to the wound. The length of incision which practically always suffices is three inches, the incision into the capsule is much smaller (Fig. 20). Long skin incisions obviously add to the risks, and are only very exceptionally needed. The incision should be slightly curved and extend from an inch within the lower angle of the patella to half an inch below the tibial margin, curving more acutely at this point towards the lateral ligament. The interior of the joint is then inspected with the aid of carefully applied retractors. No less authorities than Sir William Bennett [4] and Mr. Whitelocke [5] advocate entering the finger for exploratory purposes. The finger should never enter the joint. Neither the surgeon nor the assistants should touch the wound with anything but sterile instruments. The sutures for the capsule should be handed on forceps and I usually make the stitches a blanket-stitch. In the flexed position, the best view is obtained of the interior of the joint and the cartilage can be well inspected. If the capsule plicates and hides the view, draw it outwards with a skeleton retractor which may be used to obtain a good view in any direction. The cartilage may be found in any position. It may be detached at its anterior extremity. It may be circumferentially split; it may be completely fractured; it may be completely twisted; it may be firmly fixed but with frayed inner border; it may be nodular; the posterior part may be in front; it may be attached at its extremities and free along the whole or part of its outer border; the anterior part may be ground away, or found quite loose as a separate body, or only the slightest movement may be possible, due to a loosening of its moorings. The examination, which should be gentle, is facilitated by a sharp or blunt hook. It is only necessary to remove the loose portion of cartilage, be it a frayed border, a circumferential tear or a detached anterior portion. Here I would offer a practical suggestion. Never pull upon the cartilage nor cut when pulling; this detaches more, and to my knowledge is a cause of recurrence. Note the degree of detachment and go a short distance further with a knife cutting the cartilage clean across, and then complete the incision along the outer border. Having removed the cartilage, look for fringes, tabs or other possible agencies which may cause trouble in the future, and remove them. Stitching the cartilage should be an obsolete operation. If the cartilage is only slightly mobile and the history characteristic, it should be removed forthwith.

During the operation, dabs taken directly from the sterile drum should cover the wound during any interval, and no dab should be used which has been exposed to the air.

I never tie vessels, always use a tourniquet until the dressings are bandaged, and never drain. I used to drain, years ago, but I consider it quite unnecessary, and an additional communication between skin and joint. The synovial membrane capsule and skin should be separately sutured and the sutures should not pass through the whole thickness of the skin.

I now know no anxious moments, the skin never reddens, nor do I have trouble with effusion.

The stitches are left in position for eight days, the knee kept slightly bent in a splint for the same period, or a few days longer, and then passive movements and massage are started. Special attention should be paid to the weak quadriceps and in from three to four weeks normal exercise should be allowed.

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PARTIAL HYPOPHYSECTOMY FOR ACROMEGALY.*

WITH REMARKS ON THE FUNCTION OF THE HYPOPHYSIS,

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Rapid advances in our knowledge of the physiology and pathology of the thyroid gland followed on the heels of the early surgical experiences, showing the danger of total extirpation of goitrous tumors which, after the example of Kocher and Reverdin, were being subjected to operation at the hands of many. In some cases an acute disturbance (cachexia strumipriva) supervened; in others, a chronic state of malnutrition, which was soon recognized as identical with the condition "myxœdema," to which Sir William Gull had called attention.

These early clinical observations provoked studies which led to the discovery of the separate function of the thyroid gland and the parathyroid glandules of Sandström and Gley; to an understanding of the clinical manifestations not only of hyper- and hypothyroidism, but of tetany as well; to the modern methods of partial thyroidectomy for cases in which the gland is hyperactive and to organotherapy for conditions of deficient activity—one of the triumphs of experimental medicine.

Surgical experiences will doubtless come to play a similar rôle in helping to untangle the complexities of the functional disturbances of hypophyseal origin. Surgeons, however, cannot afford to enter into this new field too precipitously, not simply by reason of the peculiar inaccessibility of the gland—for operative resources will overcome these difficulties—but principally on account of the present uncertanties in regard to its physiological properties. We at least should profit by the lessons taught us by the earlier experiences with the operations on the thyroid, undertaken before there was a full understanding not only of the clinical consequences of total extirpation but also of the double glandular function (thyroid and parathyroid).

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* Presented at the Sixteenth International Medical Congress, at Budapest, Sept., 1909.

Surgery of the hypophysis up to the present time, with the possible exception of the case that I am about to report, has been limited solely to an attempt to remove tumors or to evacuate cysts originating either in the gland itself or in its immediate neighborhood—a period in the development of these matters comparable to the early chapter in the history of the thyroid when operations were restricted to the removal of goitrous cysts or tumors which were causing pressure symptoms. Beyond question, however, as was true of the thyroid, there will prove to be innumerable instances of more or less pronounced over-activity of the hypophysis, as well as cases of under-activity, *unassociated* with tumors; and it is necessary, before we can establish any rational basis for treatment, that we have a clearer understanding of the clinical manifestations of these states. This applies not only to surgical measures but to organotherapy as well,—for the administration of the gland or of glandular extracts, in the light of our present knowledge, must still be carried out most blindly.

I shall endeavor in this communication (1) to state briefly the existing views in regard to the rôle of the hypophysis in disease; (2) to recount the few facts which are known concerning the function of the gland; (3) to give the bare results of our own experimental work, which has served in a measure to throw light on the condition of hypophyseal deficiency (hypopituitarism); (4) to report a successful case of partial hypophysectomy for acromegaly (hyperpituitarism); and (5) to discuss the lines along which surgical measures must in the future be directed.

1. *Hypophyseal Diseases.*—To review an old story, the peculiar symptom-complex to which the name acromegaly was

given was described in 1886 by Pierre Marie; and a few years later he expressed the view, based on the post-mortem findings in certain cases, that the malady was associated with a definite enlargement of the pituitary body, either a hyperplasia or an adenomatous growth. Since then gigantism has come to be regarded as an allied condition dating from youth and likewise associated with tumor or enlargement of the gland. These observations have been followed by innumerable reports, some of them confirmatory, others opposed to Marie's view; for there have been cases of acromegaly recorded in which the hypophysis is said to have shown no pathological change, and a particularly large number of cases in which tumors of the gland or its neighborhood have been *unaccompanied* by symptoms of acromegaly.

A review of many of these latter reports, together with the study of certain patients seen in the clinic of Frankl-Hochwart, led Fröhlich to the view that a certain definite syndrome associated with adiposity and arrested sexual development was characteristic of a number of these cases of hypophyseal tumor in which manifestations of acromegaly were absent. Renewed interest in the surgery of the hypophysis followed Schloffer's proposal of a transphenoidal approach to the gland, and a few of these patients with this syndrome have since been operated upon by von Eiselsberg and others, with evident amelioration of the symptoms.

As yet, however, there has been no corroborative experimental proof of the relation either of the syndrome of Fröhlich or that of Marie to any definite alteration of the gland—far from any determination as to whether such histological alterations as have been found represented a condition of over- or under-activity. Indeed, I have been unable to gather from the writings of Marie and his associates whether, in the light of conjecture, they finally came to regard acromegaly as due to under-secretion or over-secretion of the affected gland or one of its subdivisions.

In Hochenegg's successful case of operation for acromegaly the striking shrinkage of the tissues involved in the over-growth led Stumme, who made the full report of the case, to the natural supposition that the condition represents one of hypophyseal over-activity comparable to the over-activity of the thyroid in exophthalmic goitre. However, the marked improvement which has followed similar operations with partial extirpation of hypophyseal tumors associated with the syndrome of Fröhlich in the absence of acromegaly, has led to further confusion as to the actual part played by the pituitary body in these dissimilar states.

2. *Hypophyseal Function.*—Marie's clinical observations stimulated physiologists to a renewed interest in the gland, and it was found by Howell that the posterior lobe (pars nervosa) contained a blood-pressure raising principle and by Schäfer that a substance producing diuresis was present in the same part of the gland. Here the matter has remained practically stationary so far as the results of injections are concerned.

Since Horsley's brief statement in 1886 to the effect that he had removed the hypophysis from a few dogs without appreciable effect, there have been endless reports of investigations on animals of various species by divers operative procedures which have left the question of extirpation and its consequences a most unsettled one. Some have claimed that removal of the gland is incompatible with life; others that its loss has no effect on the physiological status of the animal whatsoever. A series of successful extirpations in dogs by a new operative method, however, has led Paulesco to emphasize again that the gland is essential to life; for after a total hypophysectomy all of the animals succumbed in the course of a few days to a definite train of symptoms (cachexia hypophyseopriva); a fragment of the gland, on the other hand, was found to have been left *in situ* in all of the animals which survived.

3. *Experiences with Experimental Hypophysectomy.*—In association with Dr. S. J. Crowe and Dr. John Homans an extensive series of observations has been made during the past year which has led us to fully support the main conten-

tion of Paûlesco; namely, that at least a fragment of the gland is essential to the long continuance of life. All told, there have been over one hundred of these operations on the canine, carried out by a method very similar to the bilateral craniectomy used by Paulesco.

It is, however, upon the disturbed equilibrium of the animals that were observed for a long period after *partial* removal of the gland that I particularly wish to dwell. A number of these dogs, though kept under the same laboratory conditions as control animals, have in the course of a few months become excessively fat, and in every instance have shown marked atrophy of the organs of generation—a combination of symptoms, therefore, comparable to the clinical states of adiposity with infantilism described by Fröhlich.* It may be added that these symptoms are associated with deficiency of the anterior lobe alone and seemingly bear no relation to extirpation of the pars nervosa, though all the physiological activities of the gland hitherto recognized through injection methods are confined to this lobe. Alterations at the same time in the other ductless glands of the body are more or less constant after these partial hypophysectomies, showing the close interrelation of all of these structures—matters, however, which cannot be touched upon here.

Fully realizing that there is much that remains to be explained in regard to the function of each of the three divisions of the pituitary body, we nevertheless have been bold enough on a recent occasion,† as the result of our experiments, to advance certain views in regard to hypopituitarism and hyperpituitarism so far as the anterior lobe is concerned. Since then, through the kindness of numerous professional friends, the opportunity has been given of seeing several cases, particularly of hypopituitarism, many of them, in all probability unassociated with tumor.

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* There have been many other associated symptoms, which are beyond the scope of this paper—polyuria, glycosuria, amenorrhœa, impotence, etc.—all of them frequent accompaniments of the clinical conditions, whether acromegaly, gigantism or the adiposogenital degeneration, which are met with in company with hypophyseal tumors.

† The Hypophysis Cerebri: Clinical Aspects of Hyperpituitarism and of Hypopituitarism. The Oration at the Sixtieth Annual Session of the A. M. A. Jour. of Am. Med. Assn., July 24, 1909, vol. liii, p. 249.

I have purposely refrained in this brief discussion from making comment on the neighborhood symptoms of tumor in the hypophyseal region, though our diagnoses in the past have largely depended upon their presence; for I especially wish to emphasize the fact that conditions of hyperpituitarism and of hypopituitarism of greater or less degree doubtless occur frequently in the absence of tumor—as frequently, in all probability, as the corresponding disturbances in the secretory activity of the thyroid gland.

Had it not been for the presence of tumor or hypertrophic enlargement which definitely pointed out the seat of war it is improbable that we should have come to associate acromegaly or the syndrome of adiposity and sexual infantilism with a lesion of this hitherto obscure gland, particularly in view of the fact that our familiarity with its histological appearance in states of over- or under-activity is slight when compared, for example, with our knowledge of the finer anatomy of the thyroid under like conditions.

Though it must be considered merely as a working basis at present, it is my impression that the cases of the group Marie, with hyperplasia or the adenomatous condition which he and Marienesco describe, represent a state of over-activity (hyperpituitarism); whereas the cases in the group Fröhlich represent a condition of lessened activity (hypopituitarism) in consequence of invasion or compression of the gland by the tumor or cyst, on whose presence the diagnosis of the condition has heretofore rested.

The natural explanation of the improvement in the symptoms due to disturbances of glandular function (apart from the pressure or neighborhood symptoms) which has followed the evacuation of cysts or partial tumor extirpation in the cases of the Fröhlich type is, that remaining fragments of the anterior lobe have resumed their normal function, being relieved from pressure as a result of the operation.

Summary.—It may be said, therefore, that we have experimental evidence that a condition of adiposity with loss of activity or with definite atrophy of the sexual organs may follow the removal of a large part of the anterior lobe of the pituitary body. Hence it would seem probable that the syndrome Fröhlich is likewise a condition due to hypopituitarism.

Further, the experimental evidence is fairly conclusive that the sudden removal in its entirety of the epithelial lobe (pars anterior) of the hypophysis during a presumed state of health is incompatible with a lengthened maintenance of life—a matter of evident surgical moment in the treatment of hypophyseal lesions.

Finally, an additional case of operation for acromegaly in which, for the reasons which have been given, the gland was purposely removed only in part, will be fully recorded. It adds further support to the view of Stumme and the conjectures made by others in the past that acromegaly (gigantism likewise) is a condition due to over-activity of the gland (hyperpituitarism).

4. *Partial Hypophysectomy for Hyperpituitarism* (*Acromegaly*). Case.—The patient, J. H., a farmer aged 38 years, kindly referred to me by Dr. Charles H. Mayo, entered the Johns Hopkins Hospital in March, 1909. He complained of frontal headache, photophobia, thickness of speech from an enlarged tongue, and increase in the size of the jaw, hands and feet.

The *family history* is good and apparently has no bearing on the case.

Past History.—Patient has always regarded himself as healthy. No illness recalled with the exception of mumps at 24, a severe attack of quinsy at 32, whooping-cough at 33, and measles when 34 years of age.

He has been married seven years and has one healthy child 5 years of age. He is not impotent but has had little sexual appetite for a year or more—a condition which he attributes to his discomforts. His average weight has been of late years 175 pounds and he has gained about 10 pounds in the last few months despite his discomforts.

Present Illness.—About eight years ago he began to suffer from periodic headaches, which have increased in frequency and severity so that now the pain has become more or less constant, with exacerbations. It is referred to the depth of the head and often passes to the back of the neck, where there is considerable stiffness and an uncomfortable drawing sensation. Soon after the onset of the headaches he began to be troubled with photophobia, particularly during the attacks of pain. Otherwise there has been no visual disturbance; no history of scotomata, squint or diplopia. There has been no impairment in hearing, no olfactory or gustatory disturbance, no vomiting, no nausea.

It was pointed out to him several years ago by his friends that his lower jaw and lips were increasing in size. The subsequent enlargement has been so gradual that the change has hardly been noticeable though he is aware that his entire head, his hands and feet have shared in the growth. Eight years ago he wore a number seven shoe and at present a number eight is rather too small and he requires a larger hat than formerly.

He has had some difficulty with mastication, owing to the failure of the teeth to meet, but the face has not felt stiff and expressional movements seem normal. Speech has become somewhat husky owing to the enlarged tongue.

He complains of dizziness on resuming an erect posture after stooping; also of numbness and tingling of the hands and feet, which are cold and clammy. He suffers from cold, particularly in winter, when his fingers look like "dead fingers." During the past two years he has felt weak and worn out through constant pain, and has been pretty much confined to the house during the daytime owing to his photophobia. His bowels tend to be constipated; there is no history of glycosuria or polyuria.

Physical Examination.—A well-nourished, muscular man. The general color is dusky, cyanotic, possibly due to prolonged indulgence in antipyretic drugs.

Head.—The characteristic features of acromegaly are evident in the accompanying photographs (Figs. 2, 3, and 9). The largest horizontal circumference of the cranium is 61 cm. The jaw is markedly undershot, although without widening of the mandibular arch. The teeth, as far forward as the second bicuspids, meet fairly well, but from here the lower dental arch projects beyond the upper fully 1 cm., the possible change of position varying from 8 to 11 mm. The mouth can be opened at the widest only 4 cm. and the subjective sensation of stiffness is marked. There is considerable projection of the supra-orbital arches, evidently due to enlargement of the frontal sinuses.

Eyes.—Pupils are equal and react normally. The ocular movements are normal, though strong convergence causes discomfort. The sclera are slightly injected. The eyes are somewhat tilted, giving a slightly Mongolian aspect to the face. A perimetric examination shows normal fields for form and color.

Ears and hearing are normal, also sense of smell. The nose is large and broad, the lips thick. Nothing abnormal is shown in pharynx or tonsils. The tongue is large, thick and coated. The teeth are widely spaced (Fig. 3).

The thyroid is not appreciably enlarged. A few small glands in the right side of the neck and the epitrochlears are palpable.

The thorax is barrel-shaped, the costal angle about 85°. There is evident enlargement of the sternum, and the clavicles are large and prominent with unusual curvature. The chest is abnormally thick and the characteristic sloping of the shoulders with prominence of the upper spine is present. The heart and lungs are negative and there is no evidence of arteriosclerosis in the palpable vessels. Nothing abnormal is apparent in abdomen, abdominal viscera, or genitalia.

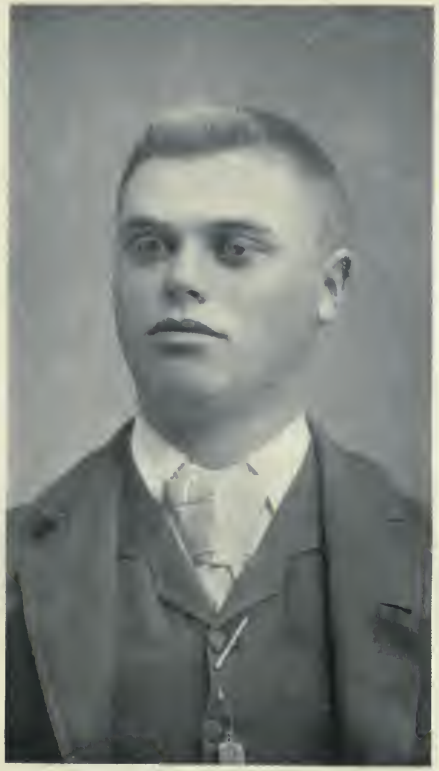
The hands and feet are large (Figs. 2 and 8), with the usual spade-like appearance due to the periosteal thickenings typical of the disease and shown by the radiogram (Fig. 4). Elaborate measurements of the fingers taken throughout show the largest circumference of the middle finger to be 8.5 cm. The hands are supple and strong, the nails normal and without ridging. The foot measures 26.5 cm. in length, the circumference of the great toe being 10.5 cm. The soft tissues of the hands, as well as of the face, feel dense as though distended with a solid œdema, which, however, does not pit on pressure.

The blood and urine are normal: no polyuria; no sugar.

A lateral radiogram of the skull shows clearly a slight enlargement of the sella turcica (Fig. 5).

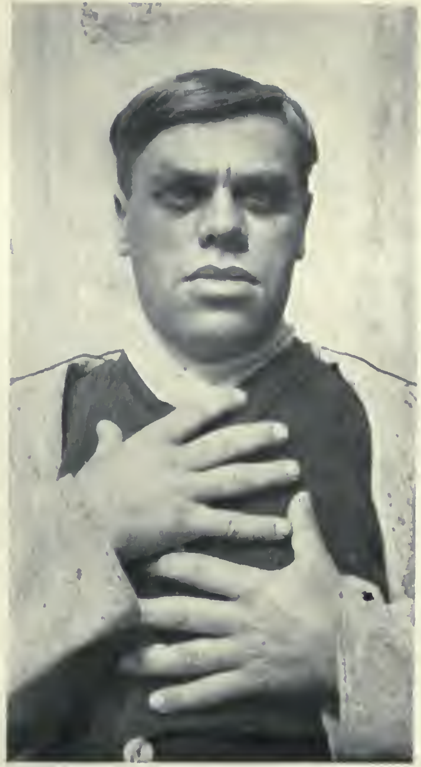
Operation, March 25, 1909.—*Preliminary tracheotomy; partial removal of the hypophysis, using transphenoidal route and osteoplastic resection of anterior wall of frontal sinuses. Closure of tracheal wound without drain.* Ether anæsthesia (S. G. Davis).

FIG. 1.



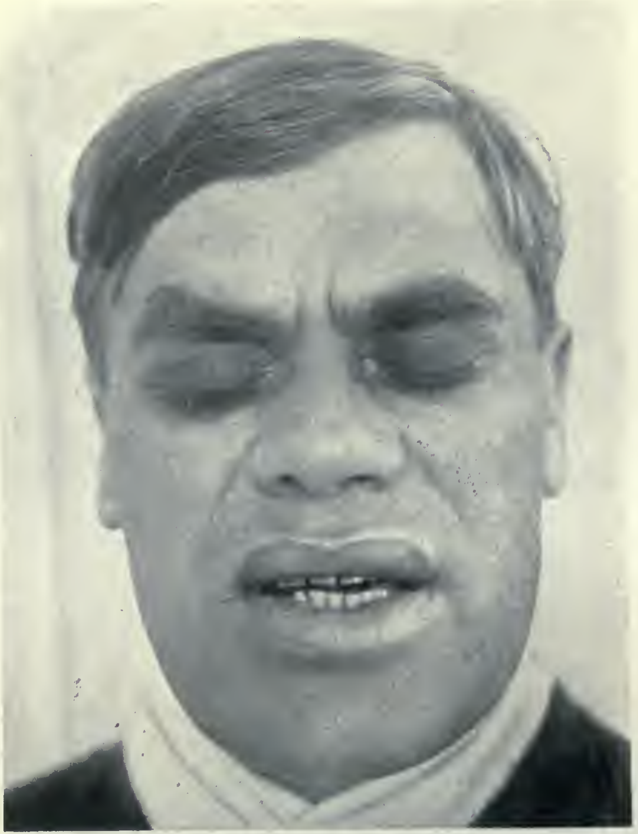
The patient some years before onset of symptoms.

FIG. 2.



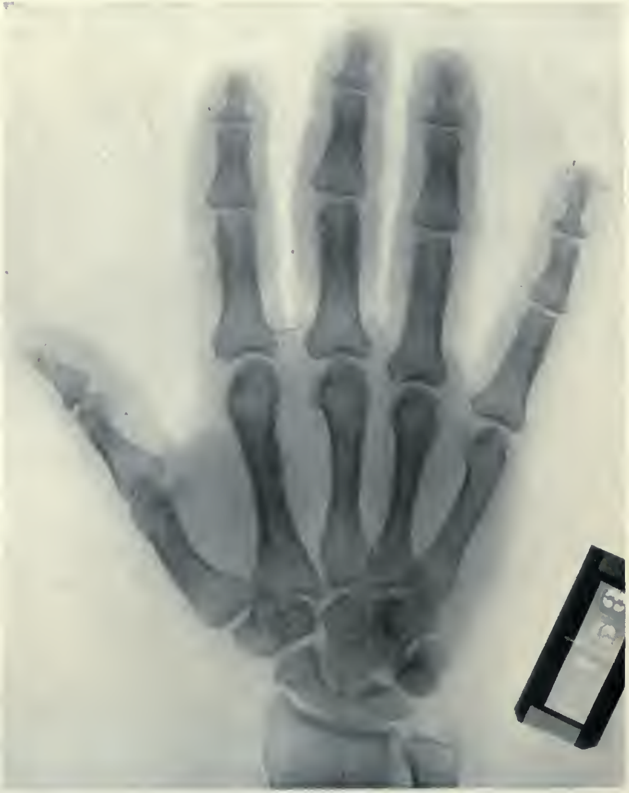
Condition on admission. (For comparison with Fig. 1.)

Fig. 3.



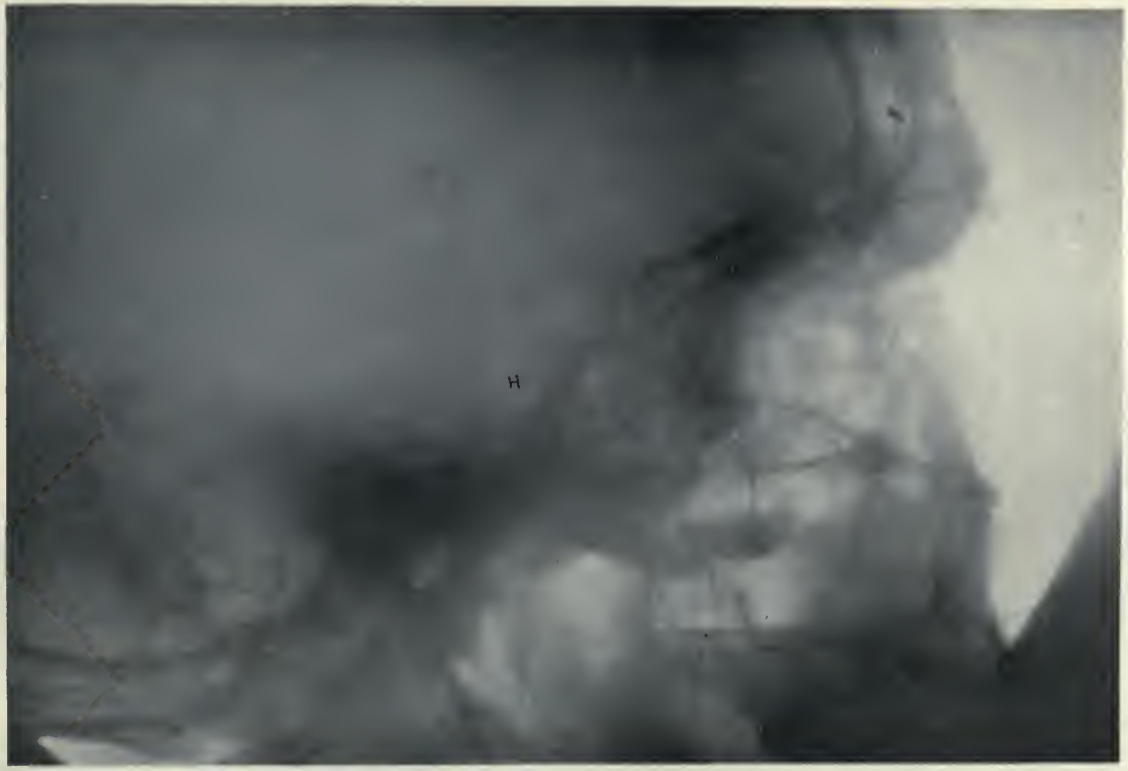
Condition before operation—photophobia. Note spacing of teeth, undershot jaw and thick lips.

Fig. 4.



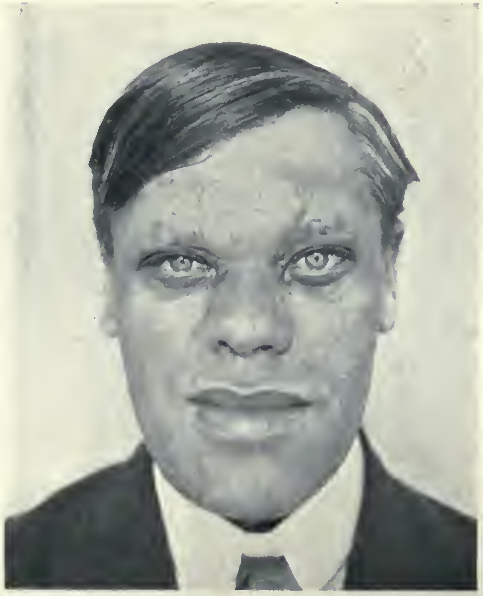
X-ray showing usual bony changes. Note thickness of soft parts.

FIG. 5.



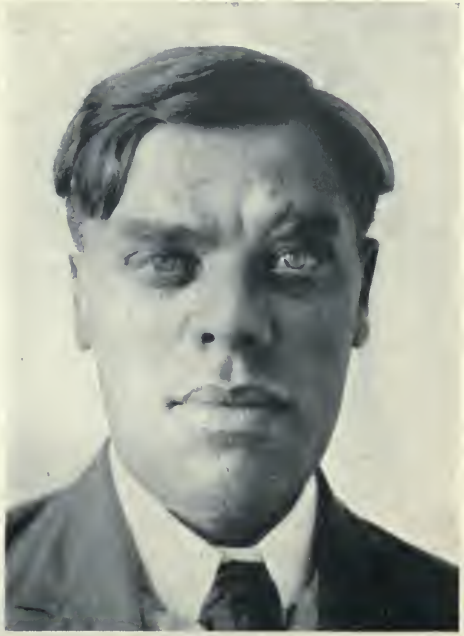
Showing sella turcica slightly enlarged, *H*. (Size—two-thirds of original.)

Fig. 6.



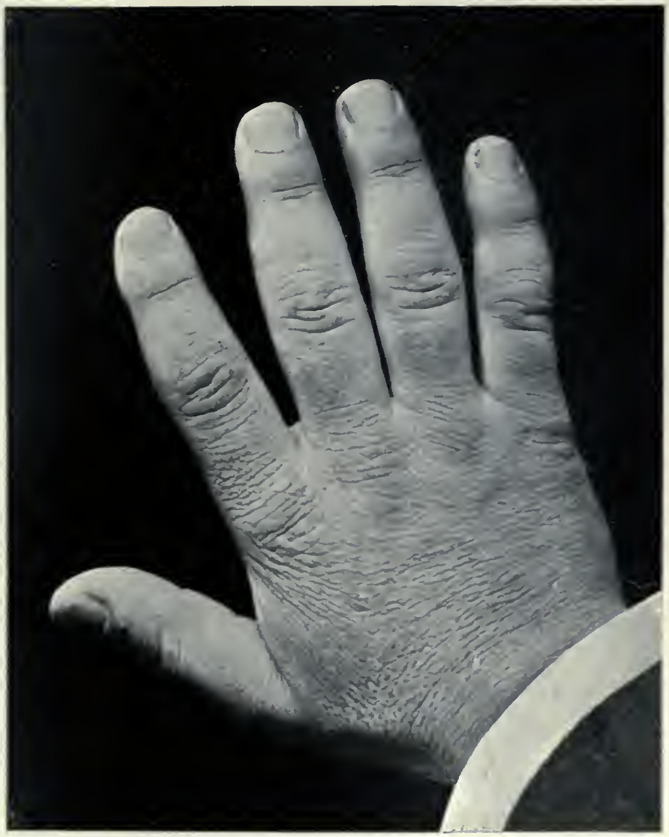
Fourteen days after operation. (To show situation of incision.)

Fig. 7.



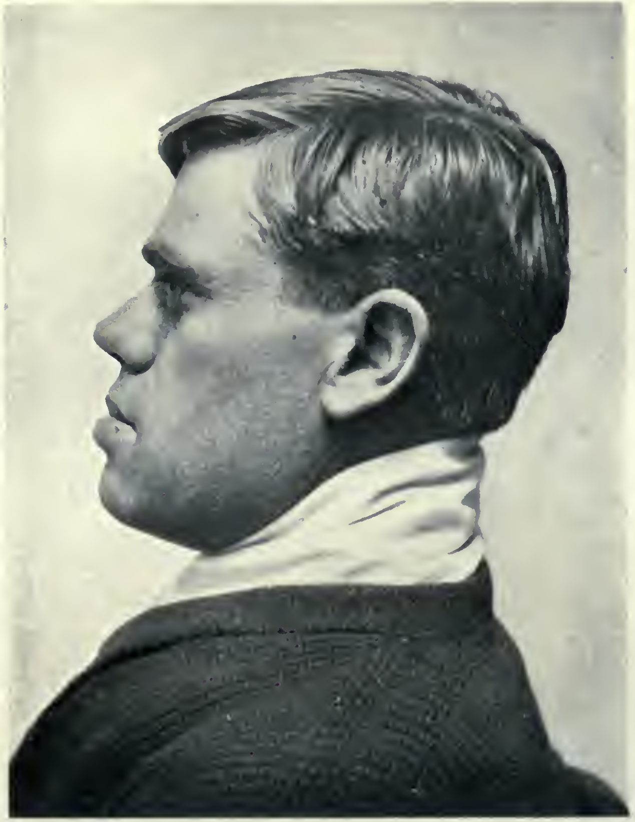
Three months after operation. (For comparison with Fig. 6.)

Fig. 8.



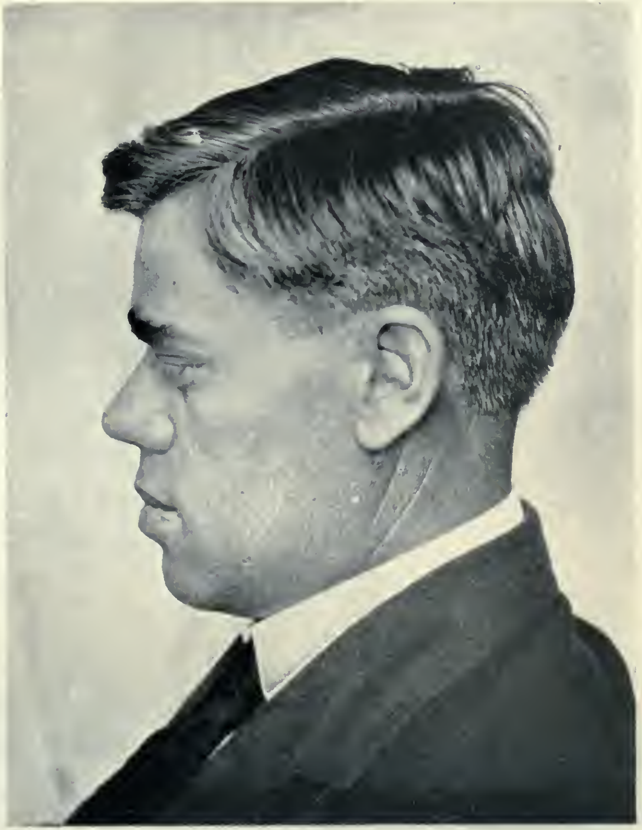
Right hand two weeks after operation, showing subsidence of "œdema" with wrinkling of skin.

FIG. 9.



Characteristic profile of acromegaly—condition before operation. (For comparison with Fig. 10.)

FIG. 10.



Three months after operation. Note considerable change in profile.

During the twenty-four hours prior to the operation four 15-grain doses of urotropin had been given. Possibly owing to the large tongue great difficulty was experienced in bringing about a state of surgical anæsthesia, and fearing complications from this source tracheotomy was performed. The trachea was exposed after division of the thyroid isthmus and removal of a section of the gland for histological purposes. The trachea was found filled with frothy mucus, which doubtless would have given trouble during the course of the operation. Warmed ether vapor was subsequently administered through the tracheotomy tube which was inserted through a transverse opening made between the second and third cartilaginous rings—a form of opening most suitable for immediate closure.

To prevent the entry of blood into the pharynx the posterior nares were then occluded with a sea-sponge held in place with a tape emerging from the nose in the usual way. The patient was then placed in the position of Rose; both nares were swabbed with a small amount of 10 per cent. adrenalin solution, and the sella turcica was approached as follows:

An omega-shaped incision (apparent in the photographs, Figs. 6 and 7) was made over the region of the frontal sinus, the lower legs of the incision converging toward the inner angle of the orbits whence they were continued down along each side of the nose to the lower margin of the nasal bones.

With a perforator and burr primary openings were made entering the outer side of each frontal sinus; a communication was made between these openings through which a Gigli saw was passed, and the upper edge of the proposed frontal sinus flap was cut from within outwards. Then with Montenovesi forceps the lateral incisions of the proposed frontonasal flap were carried downward through the nasal bones to their inferior margin in correspondence with the original skin incision. The median septa were divided with a few strokes of a thin-bladed chisel and the flap, consisting of anterior wall of the frontal sinus with the divided nasal bones and overlying soft parts, was broken loose and reflected downward.

The inner aspect of the enlarged frontal sinus, thus exposed, was roughened and contained many small mushroom-like, bony projections. The lining membrane appeared normal.

The ethmoidal cells were then carefully rongeured away until a mesial channel possibly 2 cm. in diameter was made just below the ethmoidal roof and carried well back toward the posterior part of the nasal fossa. A head-light was then employed and the position of the sphenoidal cells easily determined. Their anterior wall was broken down, and on the upper and posterior aspect of their cavity the characteristic median projection of the sella turcica into these sinuses was easily detected. The thin shell of bone was chipped away with delicate strokes of a narrow chisel, exposing the spherical pocket of dura which envelopes the gland. This dural pocket was very tense and, judging from our experiences on the cadaver, was somewhat larger than normal. It was incised longitudinally and a considerable portion —possibly one-half of the exposed gland—was removed piecemeal with the aid of a delicate, long-handled curette.

Two small cigarette drains of protective were placed from the region of the sphenoidal cells, one emerging from each nostril. The frontonasal flap was replaced and secured in position by a layer of buried sutures approximating the divided frontalis muscle and galea. The tracheal wound was then closed without a drain, four fine black silk sutures being used to approximate the edges of the transverse incision, and another, later, for union of the divided thyroid isthmus. The sponge was then withdrawn from the posterior nares.

At no stage of the operation was there any disturbing loss of blood, and at no time was the operator's view submerged—possibly owing to the adrenalin. It was surprising to find how small an opening had actually been made through the ethmoidal region and how accessible the sella turcica actually proved to be after the landmarks had once been well determined.

The urotropin was continued for several days after the operation and there were no postoperative complications whatsoever. The external wounds healed *per primam.* The last nasal drain was withdrawn on the third day; the sutures were removed and the flap supported by a collodian dressing. The patient was up three days after the operation. From the first there was practically no discharge from the nostrils. An immediate subjective sensation of well-being followed the operation, with complete and permanent disappearance of the headache from which he had suffered so long.

Though anxious to return home and quite able to leave the hospital within a week or ten days after the operation, he was persuaded to remain for seventeen days, *i.e.,* until April 11. During this interval he had called our attention to the fact that his hands seemed much less stiff than formerly; indeed, that he had not seen wrinkling of the skin such as was present for a number of years. The photograph (Fig. 8) was taken at this time in order to show this condition. There was no question but that the peculiar objective thickening of the tissues was much less marked than before. Measurements of the fingers showed that they had diminished 1 to 1.5 mm. in their circumferential measurements. His photophobia had almost entirely diminished. The one objectionable feature was the inevitable complete loss of his olfactory sense.

The patient returned to his home on a farm in the West, and after actively participating in harvesting returned to us for observation, at our urgent appeal, ten weeks later. At this time (June 24) it was quite apparent that considerable change had taken place in his appearance (*cf.* photographs, Figs. 7 and 10), seemingly due to lessened density of the tissues of face and lips. Some of the measurements seemed altered for the better. The teeth could be separated 4.5 cm. The anteroposterior movement in the lower jaw beyond the margin of the upper teeth was from 7 mm. to 11 mm. The teeth seemed to be less widely spaced. The circumference of the head was 60.5 cm. Other slight measurable alterations were made out, which possibly lay within the margin of error, so that it would be unjust at this early date to lay emphasis upon them. Before the operation my assistant, Dr. G. J. Heuer, had made an excellent plaster mask of the head and casts of the hands, which will enable us to make accurate comparative measurements in the future.

There had been no headache since the operation, very slight photophobia and only an occasional slight puffiness of the hands —much less than formerly. The speech still remained somewhat thick and the patient had no subjective consciousness of any diminution in the size of the tongue comparable to that which had occurred in the soft parts of the hands. There had been no nasal discharge. He was troubled only by the loss of the sense of smell, which had cut him off from the enjoyment of certain flavors. He had given up smoking, and now chews tobacco, and no longer cares for coffee. He had gained ten pounds in weight, but we trust that the amount of anterior lobe removed was not sufficient to produce symptoms of physiological deficiency.

The histological examination of the fragments of anterior lobe removed correspond with what we regard as a condition of glandular activity—a matter to be reserved for a forthcoming communication.

The photographs (Figs. 7 and 10) show the absence of any operative deformity.

5. *Operative Methods.*—The various routes which have been suggested as available for an approach to the hypophysis are too well known to surgeons to necessitate or justify their being reviewed here, nor is it the purpose of this paper to do so.* There are, however, certain points in regard to these procedures in general on which a personal comment may be called for.

In the first place, most, if not all, of the operations in the past have been done for *tumors* originating in the gland itself or arising in its immediate neighborhood. These tumors, as I have endeavored to show, may be associated with evidence of hyperfunction, as in acromegaly, or, in patients showing the syndrome of Fröhlich, with hypofunction. In the presence of a tumor the main surgical indication is of course the removal of the growth, with preservation of some of the normal gland if possible, and if the tumor happens to lie well above the sella turcica so that it is visible from the side, the most natural method of approach is that which has been followed by Horsley in his series of cases; namely, a temporal and intracranial route. I have attempted to follow this route in the case of an adult woman with all the characteristic local symptoms of hypophyseal tumor, accompanied by great adiposity and amenorrhœa (hypopituitarism). Though the infundibular region was easily brought into view the tumor did not project above the dural margin of the clinoid processes, and further investigation would have been foolhardy. The patient refused a subsequent transphenoidal operation which was proposed.

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* Comprehensive reviews of the purely surgical aspects are to be found in the "Sammelreferat," by Ernst Venus, in the Centralbl. f. d. Grenzgeb. d. Med. u. Chir. of this year, and in Proust's article "La chirurgie de l'hypophyse," in the Journal de Chirurgie, 1908, vol. i, p. 665.

Nevertheless, in all of our experimental canine operations we have successfully used this intracranial method, combining it with a generous opening over the opposite hemisphere to allow for the important principle of cerebral dislocation; for with this precaution the temporal lobe on the side of the approach can be elevated without danger of compression or risk of cortical injury, since ample room for the necessary manipulations is allowed by the protrusion of the opposite hemisphere through the overlying defect in bone and dura. By this procedure the canine gland can be lifted out of its shallow envelope and, dangling in plain view, can be dealt with as desired. This, unfortunately, is not true of the human gland, and the temporal operation in all probability must remain restricted in its use either to those cases in which a benign tumor (*e.g.*, of the teratoma type described by Hecht and myself) or a hypophyseal cyst projecting into the infundibular region, can be brought into view and attacked from the side. It may prove useful, therefore, as in the case just cited, as a preliminary measure to be used for orientation of the growth before the final plan of attack is decided upon.

If, on the other hand, the lesion occupies the sella turcica and is confined within an intact though possibly distended pocket of dura, an approach from one side, as so many have pointed out, is most hazardous, if not well nigh impossible; and it is in these cases that the transphenoidal operations naturally become the ones of choice. In some instances, indeed, as in the case described by Erdheim, the tumor may actually project into the sphenoidal cells rather than into the cranial chamber. All operations, however, which open up the cranial base after traversing the nasal fossa are prone to be followed by meningeal infection, and this as much as anything else has been the element which has deterred surgeons from eager acceptance of Schloffer's operation. After all, by whatever method of approach they may be attacked little can be expected of an operation for an epithelial tumor of the gland, beyond the temporary palliation of pressure symptoms, for at best their removal from this inaccessible region must be fragmentary and incomplete.

Now, leaving the tumor question aside and considering the probability that surgeons may be called upon in the future to treat certain of the conditions associated with alterations in the pituitary gland which are not necessarily accompanied by great enlargement, there can be but little doubt that the transphenoidal route will be most often followed. Of the various modifications of this operation a direct median approach through the nose is not only far less mutilating than any other midline operation, such, for example, as the intermaxillary or bucconasal procedure suggested by Gussenbauer and König, but also possesses the advantage over any lateral route, whether transmaxillary or intranasal, in the lessened likelihood of missing the situation of the mesially placed gland. The important factor seems to me to be a direct extracranial midline approach by the shortest possible route.

There are a number of modifications of Schloffer's nasal procedure, with either a mesial or lateral reflection of the nose, with or without opening of the frontal sinuses and with or without removal of more than the median septum and cells of the ethmoid. Schloffer in his first case deflected the nose to the side, sacrificed the internal wall of the orbit as far as the optic nerve and likewise the internal wall of the maxillary. As has been true of the attempts to reach the Gasserian ganglion, more heroic measures have naturally been employed in the earlier operations than have since proved necessary, and the method first carried out by Schloffer will doubtless undergo as many modifications at the hands of subsequent operators as the Hartley-Krause operation has undergone. For a time presumably no two individuals will approach the gland in exactly the same way, and whether it is desirable to combine, after the method attributed to Giordano, a temporary osteoplastic resection of the anterior wall of the frontal sinuses together with the osseous portion of the nose, or indeed whether this is practicable in conditions other than acromegaly, in which the frontal sinuses are apt to be enlarged, must be left for future determination.

Hesitation to accept the transphenoidal operation on the grounds of possible meningeal infection will be lessened in the future in view of Crowe's discovery of the rapid appearance of formaldehyde in the cerebrospinal fluid after the administration of urotropin *—a matter which is of importance not only in all of these transphenoidal operations but in cases of basal fracture or in other conditions in which infection of the meninges is threatened.

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* S. J. Crowe: On the Excretion of Hexamethylenamene in the Cerebrospinal Fluid. The Johns Hopkins Hospital Bulletin, 1909, vol. xx, p. 102.

LIGATION OF THE THYROID VESSELS IN CERTAIN CASES OF HYPERTHYROIDISM.

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THE surgical treatment of hyperthyroidism has apparently become accepted as a promising procedure for the relief of a most serious condition, notwithstanding the fact that many cases recover spontaneously or are cured by medical treatment.

Much of the fog which surrounded the early-day knowledge of this subject was due to a nomenclature which labeled the syndrome of symptoms with the names of various men who more or less perfectly described the condition. The earlier cases and those presenting irregular symptoms were unfortunate in being denied a classification. They were *pseudo* or *fruste* until they corresponded to those mentioned by Graves or Basedow in description of the disease as a finished product.

That this change from medical to surgical care is based upon rational grounds is evidenced by reports from the laboratories of the surgeons doing the greatest number of operations for goitre—from the clinics of Kocher, Halsted and many others, including our own. These reports not only show the improved condition of the patients operated upon, but they are very uniform in the stated changes occurring in the thyroid in such cases, especially as to the apparent cell activity which seems to be essential to excessive secretion.

The thyroid gland is often small or but little enlarged as compared to simple goitres, and in fact often resembles them. It received less attention from pathologists than the heart or nervous symptoms, and a more careful examination was made of other and associated organs than of the thyroid. As the treatment of the condition was symptomatic it was changed from time to time as new remedies were added to therapeutics.

The early surgical experience in Basedow's disease was unfortunate in the high mortality incident to the delayed surgery, complications and degenerations of essential organs often preventing a cure. Most of the operations were made as a last desperate resort after obvious failures of many forms of medication and other methods of treatment.

While surgery of hyperthyroidism has taken a most prominent position in the treatment of exophthalmic goitre, it has advanced along various lines. (1) By operating upon the gland itself by extirpation of a varying amount. (2) By reduction of its blood supply from vessel ligation—arterial alone, arterial and venous, and venous alone. (3) By operation upon distant organs, especially the pelvic in women. (4) By extirpation of the cervical sympathetic ganglions, and (5) more recently the injection of cytolytic serum has been added.

Greater operative experience upon cases of hyperthyroidism has led to a great reduction in the mortality. This has come about through many changes, *i.e.*, earlier operation, better operative technic, more careful preparation of patients, choosing the operation to suit the case, and the graduated operation.

The anastomosis of circulation in the thyroid is very free. When we consider that this circulation is so extensive in proportion to that of the brain, that the vessels arise from points closely associated with that of the brain, with a blood supply which cannot be destroyed except by deliberate act, and that it has free venous return, had we no knowledge of its function we could still easily understand the importance of the organ.

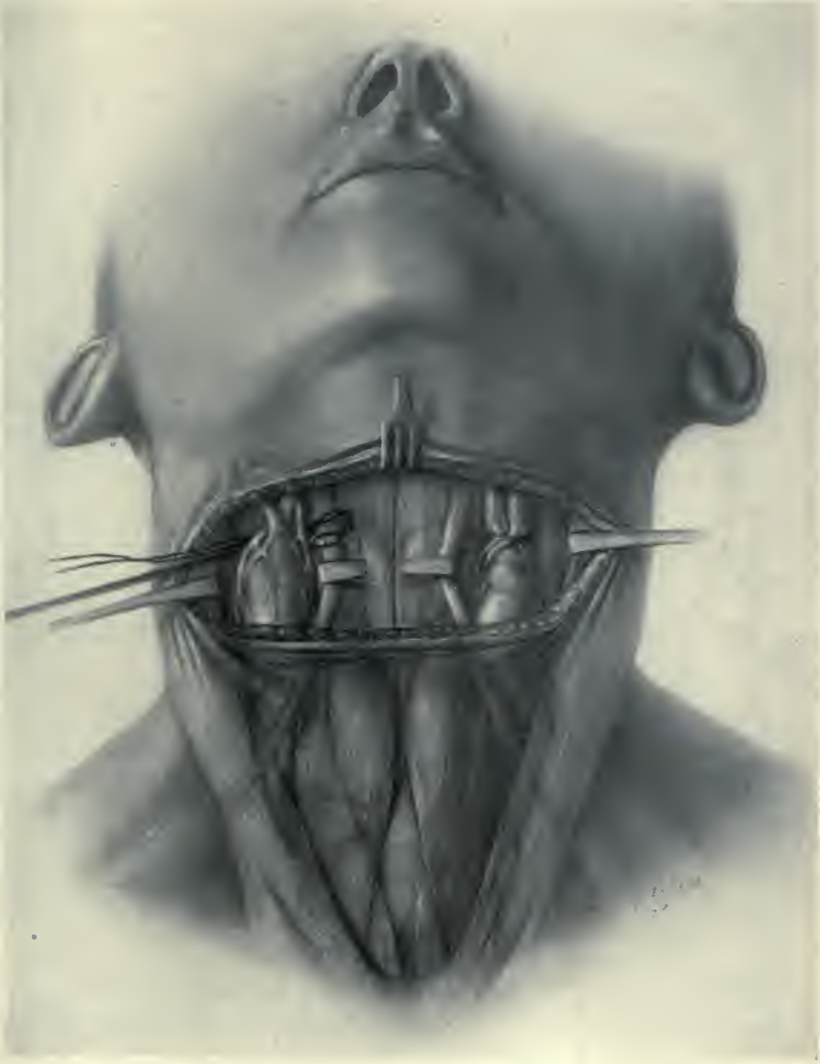
The earliest ligation of vessels as an operation for the relief of goitre is credited to Wolfler. Our experience with this procedure covers over 200 operations, and with the results obtained by this method we consider that the ligation of certain thyroid arteries and veins, and at times a portion of the gland, seems indicated in some cases of hyperthyroidism.

First, in those suffering from mild symptoms of hyperthyroidism, and those in whom the diagnosis is made early, possibly before the less important eye symptoms or even goitre is present. In cases which are hardly severe enough to warrant a thyroidectomy, the ligation of the vessels will often produce a cure in a few weeks with but little risk and without the necessity of special medication.

Second, ligation is indicated in that larger group of acute, severe exophthalmic goitres, and in the chronic and very sick patients, who, having exhausted all forms of treatment are now suffering with various secondary symptoms—dilatation and degeneration of the heart, fatty liver, soft spleen, diseased kidneys which have resulted from the chronic toxines as seen in the later stages of Graves' disease—changes which after all are the final cause of death. This operation is of particular value in those cases with a marked pulsation and peculiar thrill of the superior thyroid arteries.

All severe cases of hyperthyroidism when suffering from œdema, ascites, dilatation of the heart, diarrhœa, gastric crisis of vomiting, should be under observation for a short time at least, and some of them for a considerable period of time to improve their condition if possible, before even a ligation be attempted. There is a time in the progress of these cases when terminal degeneration of essential organs has advanced so far that they are no longer curable. When surgery is applied as a last resort it may be possible by using some special great dexterity and care, to remove part of the gland without an immediate fatal result. While the disease may be checked, these patients are seldom sufficiently benefited to warrant the immoderate risk of an extirpation. On the other hand, at such times many cases which have at first appeared to be unfavorable subjects, will so far improve under symptomatic treatment aided by rest, hygiene, X-ray, etc., as to become suitable operative subjects at a later period. It is in this class of cases where ligation as a preliminary procedure is of great value. The relative safety of ligation as compared with that of thyroidectomy may lead the operator to accept as surgical risks patients so far advanced in the disease as to have but little prospect of cure. In operating upon these cases the surgeon should use his judgment as to the time and method of

FIG. 1.



Ligation of the superior thyroid vessels.

operation, and the anæsthetic to be used, from observations according to the improvement manifest under preparatory treatment.

Anæsthetic.—The choice of an anæsthetic must be left to the individual surgeon, but the immediate surroundings and the ability of the assistants may often modify conditions. Some surgeons like the use of chloroform, others gas and oxygen. We prefer ether on the open mask. Occasionally there are advanced cases in which we use local anæsthesia—one-tenth of one per cent. solution of cocaine in normal salt solution—beneath the skin, to create œdematous tissue. A hypodermic of morphia sulphate gr. $^1/_6$ and atropine solution $^1/_{100}$ is given thirty minutes before general anæsthesia is used. The more restless, nervous and hysterical patients do well with scopolamine morphia $^1/_{200}$ to $^1/_{150}$ one hour preceding the operation with local anæsthesia.

Operation.—A transverse incision gives the best working space as well as the least disfiguring scar. It is made two and a half inches in length, crossing the central part of the thyroid cartilage. The incision should be made in a natural skin crease if possible and should include the platysma myoides, this one incision being better than two lateral. The inner border of the sternomastoid is tracted laterally. This exposes the omohyoid muscle which is tracted up, and in toward the midline. Beneath this muscle is the upper pole of the gland with the superior thyroid artery and vein.

The ligating material is linen passed by an aneurism needle. Should a vein be pierced and a hemorrhage follow the placing of the ligature, it is tracted upon, and a second loop is passed around including more tissue. In most cases this is preferable to a more generous incision with freer dissection. The veins are purposely included to secure venous obstruction, the free anastomosis within the gland capsule making this of advantage. One need not fear the ligation of a nerve in this location, as the inferior or recurrent laryngeal is below. The wound is closed by a subcuticular suture without drainage.

The location of the ligation at the pole of the gland is important, as in one of our cases in which the superior thyroid arteries had been previously ligated at a point where they were given off from their origin at the external carotid, there was but partial and temporary relief. At the second operation we found a reversal of the circulation in the large inner branch anastomosing with the inferior thyroid, and in the upper part of the gland the circulation was but little reduced.

The after-care of these patients is according to the severity of their symptoms. Rest in bed, slow saline by rectum often repeated. Patients will usually absorb several quarts of the solution within twenty-four hours, but should they be subject to diarrhœa the rectal saline may not be possible. In such cases, if from the severity of the symptoms it is especially desirable to use salines, they are given subcutaneously.

Most of the patients are in a serious condition when operated upon, and a few develop very alarming symptoms. For these scopolamine can be given in doses varying from $^1/_{200}$ to $^1/_{150}$ to control the great muscular restlessness, and injections of strophanthin and digitalis may be used with caution. Adrenalin will slow the pulse but should be used with care at this time because of the strain upon the heart muscle. Camphorated oil 10 to 15 minims hypodermically is a useful stimulant. An ice-bag over the pericardial region is of benefit. The danger after operation continues for several days in the more severe cases.

Not only is the body charged with excessive secretion but as the gland contains at the time of ligation much secretion for absorption, therefore the general progress of these cases toward recovery is not so rapid as where a definite quantity of the gland tissue can be removed.

In the large hard glands of hyperthyroidism where some reversion has occurred with colloid deposit, ligation is not indicated.

The changes in the gland after ligation are most interesting. There is a change from the great increase in cell development back to a condition of simple goitre. This is produced by a simple exfoliation of cells and does not resemble the degenerative changes which are found in the glands removed in the late stages of Basedow's, or those in which serum treatment has been used. In both of these there is a true cytolysis or chemical destruction of the cell.

Five hundred and eighty patients suffering from hyperthyroidism or exophthalmic goitre have been operated upon at St. Mary's Hospital. Of these 225 were ligations of the superior thyroid arteries and veins. A number of these ligations have been made too recently to base observations upon except as to the immediate risk of operation, which is about 2 per cent. in deaths occurring within a few days. Ten of these cases were operated upon too late and did not improve, but continued in their downward progress, dying in from eight to ten months later of their disease. In these deaths is included a case of pernicious anæmia.

We now have full records of 138 cases which were ligated sufficiently long ago to make their report of value.

There were 12 cases of ligation of the remaining superior thyroid artery and vein following thyroidectomy of the larger lobe and isthmus, the primary operation being followed by relapse after one or several years with growth of the remaining lobe.

Twenty-eight cases of thyroidectomy followed the ligation of both superior thyroid vessels. Although all of them were very severe cases at the time of ligation, there was no mortality from the second operation.

In cases of ligation without thyroidectomy the results were as follows:

	Cases.
Slight improvement	9
Great improvement	44
Very marked improvement	11
Absolutely well	4
Cases of questionable exophthalmic goitre, no improvement	9

Of this latter type there are two classes: (1) Some peculiar cases of myocardial trouble, and (2) those in which the nervous symptoms predominate. Both classes are associated with other symptoms of hyperthyroidism. It is possible that in some of these the symptoms come from changes in other ductless glands, especially the suprarenal; as yet they remain to be better described.

While many patients reported indefinite gain in weight, there were 68 cases in which an accurate report was given, showing that 62 patients gained an average of 20½ pounds from three to five months after operation. If cases were excluded that were about normal weight at the time of operation the average gain would exceed this. Six patients lost an average of 6 pounds. Most of these were but little reduced at the time of operation.

In the majority of cases the ligation is made as a definite step in a graduated operation to reduce excessive secretion of the gland, and some of the reported cases are yet to be operated upon for the removal of part of the gland as a secondary procedure. Some of the patients in this series consider themselves too well at present to undergo another operation, and will probably do so only under the stress of a relapse of their symptoms, when it may be advisable to ligate the right inferior thyroid artery as a second step toward thyroidectomy. We found this procedure of value in nine cases. On several occasions, because of the various seemingly urgent reasons involving the safety of the patient, we deemed it advisable to convert a thyroidectomy into a ligation of vessels.

THE SIGNIFICANCE OF THYROIDISM AND ITS RELATION TO GOITRE.*

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In April, 1905, the first patient suffering from Graves' disease was treated with the specific antithyroid serum prepared by Dr. S. P. Beebe in the laboratory of the Cornell Medical College. During the course of the following year it became apparent that this antiserum was not beneficial for all cases, and other organic products, to be referred to later, were introduced, and in the comparison of the results obtained by the use of these different substances and by the ligation of one or more of the thyroid vessels or extirpation of a greater or less amount of the gland much valuable information has been obtained. Four hundred and eighty cases representing all stages and varieties of thyroidal disease have thus come under my personal observation for a greater or less length of time, and Dr. Beebe has records of about as many more who have been treated with his laboratory products by many other physicians. In my series approximately 15 per cent. have been cured of all traces of their disease; some 10 per cent. have no abnormal subjective symptoms but still retain signs generally of goitre—less often of exophthalmos or other indication of their disorder noticeable to the trained observer; about 50 per cent. have been improved to a greater or less extent, which usually means that after a month or two of treatment, with alleviation of symptoms, the patients have passed from observation and may at present be better or worse than when last seen; about 17 per cent. have failed to show any improvement and 8 per cent. have died from the natural progress of their disorder, in which class there must be included two cases occurring early in my experience, one of which perished within eighteen hours after operative removal of one lobe and the isthmus of the thyroid and the other within seventy-two hours from an acute exacerbation of the pre-existing thyroidism apparently caused by the injection of antithyroid serum at too frequent intervals. These statistics emphasize the gravity of the prognosis of what is commonly believed to be a benign affliction and are the more sinister in that so-called thyroidal disease seems to be becoming more prevalent, at least in the hospital wards in this city. In this whole series there have been observed only three cases of malignant disease of the thyroid, and these were inoperable when first seen.

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* Read before the New York Surgical Society, November 24, 1909.

In the attempt to elucidate the manifestations of pathological physiology there are to be considered, first, the natural history of the diseased process; then the effects upon it of more or less specific therapeutic interference, or measures which more or less obviously affect the organ or organs known or supposed to be at fault; and, lastly, from the data thus derived there remains the proof of the theory of the diseased process by its reproduction experimentally in animals, an achievement which has not as yet been accomplished,—but if the hypothesis which can be constructed chiefly from clinical data is correct, the experimental evidence should be obtainable.

Typical exophthalmic goitre usually begins insidiously and may pass through the stage which is generally conceded to be dependent upon an excess of thyroid secretion, to terminate in myxœdema or a condition dependent upon an insufficient amount of secretion. As the symptoms which are produced by well recognized disease of the thyroid gland vary so greatly in different cases, it is advisable to trace the whole process clinically from beginning to end.

Incipient Stages of What May be Later Exophthalmic Goitre.—At the outset there is almost always a history of more or less prolonged mental and physical strain. There is an insufficient amount of sleep and rest and an excess of worry and cerebral excitement combined at the same time with marked physical effort. Common examples are a wife caring for a sick husband or a mother for her child in a prolonged illness. Often it is a young girl who at a period of maximum growth and development is forced to study early and late or to take a wage-earning position under trying circumstances; or there is a history of one or more surgical operations or some severe infectious disease before the onset of the disturbance. The first symptoms noted are those of simple over-fatigue and perhaps of anæmia, although the hæmoglobin may be only slightly below the normal percentage. There is delay and difficulty in getting to sleep, or a considerable insomnia; the appetite falls off and there is some constipation; the cerebration is over-active but not capable of sustained effort, and an irritability of temperament or melancholic ideas which are not inconsistent with the usual surroundings, may appear. About this time considerable muscular weakness is evident and is naturally ascribed to the insufficient sleep or to the unusual strain under which the patient is passing; but throughout the disease this muscular weakness, sometimes described expressively as extreme "fatiguability" is very characteristic and often belies the general appearance of good nutrition. With this there is some dyspnœa on exertion; but a more evident sign is the "thumping," over-acting heart, which is most likely to be felt at night on going to bed. Tachycardia is usually intermittent at first and occurs after any slight exertion, and so is often overlooked or ascribed to the wrong cause. Later it becomes more frequent and is felt without appreciable reason, though some emotion combined with indigestion may be apparent on close inquiry or observation. Constipation and intestinal fermentation with coincident palpitation or "throbbing" heart and some insomnia, are such common complaints that they may be thought unworthy of notice, but they differ only in degree from the similar and more serious manifestations which are evident later when the disease has become fully established. Only in that later period the intestinal disturbance has more often the form of frequent, partly formed or loose stools, or of diarrhœa; but throughout the whole progress of events there appears to be a somewhat vague and yet distinct connection between the emotions or central nervous system, the heart, or vasomotor apparatus, the digestive tract,—and in this the liver must be extremely important, and the muscles. The participation of the thyroid gland in the disturbance at this stage can only be inferred by the marked if not always beneficial results consequent upon the administration of thyroid substance and by the unmistakable symptoms which will appear later if the disease is allowed to take its usual course.

The incipient period of greater or less nervous and physical exhaustion, with its insomnia, loss of appetite, indigestion and fermentation, constipation, occasional or constant rapid heart action and subjective sensation of heart "thumping" and the mental excitability or nervousness, may terminate under common sense and hygienic treatment in complete or partial recovery, or after weeks or months under less favorable circumstances, in typical exophthalmic goitre.

That the disease does not always seem to begin as above indicated, need not be contradictory of the general principle that it starts as a disorder of nutrition: it sometimes, for instance, is first noted after a severe infection like typhoid fever or tropical malaria. Rarely it seems to arise suddenly and from traumatism or extreme emotion, as after a runaway or automobile accident or after the receipt of distressing news.

Under the first of these conditions the explanation necessary for establishing the unity of apparently dissimilar causes must lie in the fact that the mechanism of resistance to bacterial infection undoubtedly taxes nutrition to the utmost, and the only wonder is that exophthalmic goitre is not a more frequent sequence, for the seeming participation of the thyroid in the defensive process will be indicated later.

A sudden origin of fully developed Graves' disease, however, is not so readily accountable, and involves a belief that it must have existed in a latent or unrecognized form for some time previous to the plainly evident manifestations, or that the thyroid must have possessed some inborn or acquired weakness to permit the perpetuation of symptoms which may occur normally as a transient phenomenon attendant upon extreme nervous and physical fatigue; the sudden appearance of typical symptoms and their speedy subsidence is evidently possible. The indefinite continuation which constitutes the phenomena of Graves' disease must, however, presuppose a preliminary masked stage or a previously weakened or inherently poor thyroid acting for some time to its fullest capacity and then suddenly over-taxed. Why some manifestly incipient cases, like the "overtrained" athlete or overworked school girl, should recover under simple hygienic measures, while others, in spite of this care, progress to the typical chronic disorder and perish directly or indirectly from it, remains to be considered. The most obvious explanation lies in the degree of severity to which the incipient stages have advanced and the inborn vitality or character of the organ which appears chiefly at fault.

That the disease may apparently develop suddenly is nevertheless conceded; but an attempt has been made in the above to show that this suddenness of onset is more apparent than real, and when other explanations fail to provide for this variation from the usual slow onset attended or caused by disorder or deficiency of nutrition, an inborn weakness of the thyroid must be seriously considered to account for its pathological physiology.

The Symptoms of Exophthalmic Goitre in the Early Stages.—The prominent symptoms of exophthalmos, goitre, and tachycardia, especially the first two enumerated—from which the expressive designation of the disease is derived, vary so much in different cases and even in the same case at different periods, and are so little characteristic of the most dangerous type of the disorder, that the term thyroidism is suggested and will be employed here as being much more comprehensive and less liable to induce error in diagnosis. For in all the various manifestations of this process the thyroid gland seems to be the key to the situation; and unless the effects of thyroid feeding may be so considered, no one sign is pathognomonic of the thyroidal participation. Therefore, exophthalmos and goitre at least must not be understood as at all necessary to establish the diagnosis of thyroidism, and reliance must be placed upon less noticeable symptoms. Among these a certain degree of intermittent or constant tachycardia and general vasomotor irritability with sudden cutaneous flushing under the slightest excitement are very constant, as is also the subjective sensation of heart "thumping" at such times. The peculiar muscular weakness which often belies the appearance of good health, is also very noticeable in all forms of thyroid disorder. Quick, jerky movements of the extremities, a sign which may be dependent upon the muscular weakness as well as upon the nervous excitability, and the fine tremor in the stiffly extended fingers, are quite noticeable.

In these early stages the susceptibility of the patient to heat and the tendency to perspiration is in striking contrast to the dry skin, cracking nails and dread of cold, which are some of the most constant signs of a beginning insufficiency of the thyroid or myxœdema. Insomnia, morning headache, an appetite out of proportion to the evident illness and a thirst for water which increases with the intensification of the diseased process, generally precede and accompany the exophthalmos and the goitre. When the disorder is of the severe type there is always a temperature of 99° to 100° F., and as it becomes more intense the temperature rises. The character and color of the stools is also significant, not of thyroidal disease, but of the organs which become involved in the progress of the disturbance. For with exacerbations or with intensification of the typical Graves' symptoms the movements from the bowels become light-colored and diarrhœic. The blood seldom shows more than slight anæmia, but there is almost always a lymphocytosis which is somewhat proportional to the severity of the symptoms, and the urine regularly contains an amount of kreatin which varies in the same way and increases with the severity of the thyroidism in this period.

The early or mild symptoms of exophthalmic goitre may continue for months or years and spontaneously or during or after pregnancy, or, under some form of treatment, gradually disappear until complete recovery has occurred. But recovery never takes place suddenly or even rapidly. Restoration to the normal condition always, like the beginning of the pathological process, requires a considerable period of time. Rarely the early stages pass within a few days into the toxæmic stage with high temperature, quick, labored respiration and rapid pulse with irregular, tumultuous action of the heart. There is a dry tongue, nausea, vomiting and diarrhœa and often extravasations of blood in various parts of the body. The whole picture is one of a violent septicæmia or septic intoxication with vasomotor, nervous and gastro-intestinal symptoms predominating, and—as Dr. W. G. Thompson has pointed out—is not unlike that of malignant endocarditis, for which it is frequently mistaken, particularly if neither exophthalmos nor goitre are perceptible. In their absence the diagnosis must generally be made on the history and by careful exclusion; but in the toxæmic stage it is evident that the liver is involved along with the gastro-intestinal tract, for this organ is usually enlarged and sometimes reaches two or three finger breadths below the ribs and is tender and painful and there may be perihepatitis. These patients also complain bitterly of pain referred to the epigastrium. It may or may not have to do with the liver, but seems to be in direct proportion to its enlargement and tenderness. If death occurs it will be preceded by a rising temperature, vomiting, diarrhœa, headache, and delirium and stupor. Rarely there may be a gradual subsidence of the symptoms and, as after the mild early stages, the patient will pass into the chronic form of the disease.

Chronic Exophthalmic Goitre, or Chronic Thyroidism.—In this stage the exophthalmos and goitre are more constant and pronounced than in the early stages; but even if one or the other or both should be absent the diagnosis ought to be evident from the vasomotor and nervous irritability and the muscular weakness. In this period, however, there gradually appear some lesser symptoms which sharply contrast with those in the earlier stages. The skin instead of being constantly moist becomes more and more dry and perspiration, if present at all, is only noted after exertion or excitement. There is less complaint about heat and more about cold. The constant thirst so marked at the outset decreases and the appetite is not so good. A marked pallor often showing a brownish or yellowish tinge succeeds the usual flushed appearance of the early period of the disease. Some œdema of the eyes may occur, or puffy swellings which come and go in the skin and subcutaneous tissue about the eyelids and face, or in the supraclavicular region, or in the fingers, and stiffness of the hands is felt; there is also a tendency to nosebleed, and subcutaneous ecchymoses are produced by the slightest traumatism. The tachycardia gradually lessens but may be pronounced at times, especially after any slight gastro-intestinal disturbance or fatigue, or at the menstrual period, or without appreciable cause. Some tension appears in the radial pulse and may become marked. The tremor and nervous irritability become less and less noticeable but are usually apparent during emotion or fatigue and absent in periods of quiet.

The exophthalmos is so extremely variable, and it is so often absent even in cases which are severe and otherwise typical, that one is almost forced to believe exophthalmos to have an origin from some other organ or group of organs and to be only indirectly connected with the thyroid. The goitre in the chronic period instead of being soft and smooth in outline becomes more and more dense, nodular and hard, and generally shrinks in size. The temperature is constantly below and not a trifle above the normal point. The blood examination shows only a simple anæmia, which may be considerable; but there is no excess of lymphocytes or small mononuclear leucocytes, and the urine is generally normal and contains no excess of kreatinine, but there may be occasionally some albumin. The psychoses which sometimes appear in patients showing the symptoms of Graves' disease, occur in this later chronic stage and suggest a disordered nutrition of the nervous system rather than an intoxication. The mental disturbance is somewhat peculiar and not readily classifiable, and while there may be pronounced delusions they are not consecutive and persistent. The mentality is rather wandering or vague and of erratic purpose. Also, these psychoses are more common in asthenic weakly or poorly nourished individuals, and if improvement in general nutrition can be produced they may subside or disappear.

During the late chronic period, with approaching myxœdema the weight may improve but the strength persistently remains poor or deteriorates, and at any time severe or fatal exacerbations of toxæmic thyroidism may occur, and are apparently often brought about by unusual nervous and physical strains. Gastro-intestinal disturbance, with light or clay-colored stools and constipation, later followed by diarrhœa, seems, however, a more frequent cause or accompaniment of the severe exacerbations in this stage than in the early periods of the disease. The toxæmia shows the same nervous and vasomotor irritability as in the earlier periods, but the fever is much less and the advance towards the fatal termination is slower and apt to be attended by œdema of the legs or ascites or general anasarca. A few of these patients may even improve at this stage and then suddenly drop dead in syncope, especially if the goitre has become inelastic, hard and nodular. Sooner or later—the time seems dependent upon the severity of the process—there always develops some enlargement of the liver. At first this organ will perceptibly vary in outline from day to day or from week to week with exacerbations and remissions of the general condition. The increase in the size of the liver occurs at first quite rapidly, and with this there is pain so that one is forced to believe in a localized and very marked congestion. Then if there is a subsidence in the tachycardia, nervousness, and gastro-enteric disturbance, the lower border of the liver may approach the costal margin by one or two finger breadths in as many days, with relief of the pain; but this hypertrophy is almost sure to recur. It marks, I think, the beginning of the end, as after it has once appeared I have never known such a case to recover, though life may be prolonged some weeks or even months.

This enlargement is generally regarded as caused by congestion dependent upon blood stasis and cardiac failure. But it often occurs without manifest insufficiency of the heart, and hence is probably due to reasons other than circulatory. It is enough, however, to note here that the liver sooner or later becomes involved in the diseased process.

Myxœdema Stage.—If the patient survives the dangers of the chronic stage of exophthalmic goitre, the nervous and vasomotor irritability and exophthalmos become gradually less and less noticeable until they disappear. The goitre, however, may persist or rarely enlarge, but the muscular weakness slowly increases until the head may drop forward and rest with the chin on the sternum and complete helplessness supervenes. The peculiar pallor of the skin, often with a slight flush over the malar bones, the puffiness about the eyelids and lips, the dense œdema—especially in the lower extremities, the mental torpor and the slow pulse and the anæmia, all constitute a picture too well known to require repetition. But the myxœdema following Graves' disease usually leaves some traces of the original disorder and only occasionally is of the classical type of congenital or unknown origin and of slow development. Some sign of exophthalmos may persist or the slow pulse may show brief periods of rapidity, and there is very commonly more or less indigestion—generally of the fermentative type. Occasionally there may be attacks which look very much like a gall-stone colic, with nausea or vomiting and light or clay-colored stools, and I have known at least one of these cases to have undergone exploratory laparotomy with entirely negative results.

The prognosis of the myxœdema, or myxœdematoid condition, following thyroidism or exophthalmic goitre, is also, I think, more unfavorable and less amenable to treatment than is the variety of spontaneous or unknown origin. Some of these cases suffer much from lipomata in various parts of the body, and indeed there is much which is suggestive of, if not identical with, the disease called adiposis dolorosa. In general it may be said in conclusion that all cases of exophthalmic goitre which do not recover spontaneously or under treatment, during the early typical or early chronic stages, or which do not perish in these periods from exacerbation of thyroidism, finally die with an atypical myxœdema.

This brief review of the natural history of the disease suggests an apparent origin in over-strain and coincident or consequent malnutrition, and that the thyroidism which follows may have some elements of a protective or compensatory mechanism which has become perverted and harmful. Also that its tendency is towards indefinite continuation, and in a manner the disease seems self perpetuating.

The not infrequent exacerbations of the process are apparently brought about by over-strain or by incidental infections, like tonsillitis, and are accompanied by more or less marked digestive disturbances, as is the case in the beginning.

SIMPLE GOITRE.

Simple goitre or hypertrophy of the thyroid gland is usually considered to be a disorder which is entirely distinct from Graves' disease and to represent a totally different pathological process; but there are many reasons for doubting this conclusion and for suggesting something of the same pathological physiology at least in the origin of both exophthalmic and simple goitre. In the first place the family histories of these cases show a very distinct prevalence of both conditions. The predisposition to goitre, like tuberculosis, is very often traceable through several generations, or it appears in several members of a family, and though distinct Graves' disease may occur only occasionally and as an exception in these individuals, goitre without any apparent systemic disturbance may be a family peculiarity. This, if it indicates anything, only suggests an organ of congenital weakness. The hypertrophy is at first soft and symmetrical and is most often noted at about the period of puberty and at the menopause, and is much more common in women than in men and in subjects who are not robust though they may appear stout and well nourished. The "nervous" element, as in the exophthalmic form of the enlargement, is generally quite noticeable, and individuals with goitre are usually very susceptible to favorable or unfavorable surroundings. Given the causes which apparently produce exophthalmic goitre—namely, a combination of nervous and physical strain—and these patients with simple symmetrical goitre are very prone to suffer with more or less typical thyroidism, which may subside or continue indefinitely. The unfavorable hygienic circumstances which accompany the development of simple goitre and the period of life are also the same as those which precede Graves' disease or the exacerbations of the process.

There is another group of cases in which the goitre seems to be of the same character and to arise in the same way but later, under favorable conditions, instead of entirely disappearing, does so only in part, and more or less of the gland remains enlarged and gives the physical signs of a circumscribed, tense, elastic cyst. Then, under emotion, excitement or physical strains, this will temporarily swell, and coincidentally there will be more or less marked signs of thyroidism, with tachycardia, dyspnœa, insomnia, general "nervousness" and weakness, but usually no exophthalmos unless the unfavorable conditions persist too long. Not infrequently the dyspnœa is attended by a feeling of constriction of the throat and stridulous breathing, which indicates actual compression of the trachea. Under rest and good hygiene all the symptoms except the circumscribed enlargement of the thyroid generally disappear, but are easily again excited, and in course of time other areas of the gland may become involved, and the signs of thyroidism—instead of being intermittent—become continuous, and are generally mild though showing occasionally severe exacerbations, and are then accompanied by exophthalmos.

These cases in which part of the gland appears normal and part to have undergone adenomatous or cystic degeneration behave like a "leaking retention cyst" in which the supposedly retained secretion is toxic and only escapes into the circulation under unusual conditions which are apparently connected with emotion, fatigue, gastro-enteric disturbances or bacterial infections or traumatism. It is generally believed, if not actually proved, that normally the escape of the thyroid secretion is through the lymphatics, and in the above cases the whole picture suggests a primary diffuse hypertrophy with at least more than the usual functional activity. In this process there may occur a localized obstruction of the lymphatics with retention of the colloid and degeneration of the epithelium. Under favorable conditions the remainder of the gland, which may never by the way have been noticeably enlarged, returns to the natural size and state, but the damaged portion remains, and whenever the organ is called upon, as it seems to be automatically, to increase its activity during nervous and physical strains of all kinds, the resulting congestion induces a leakage into normal or abnormal lymphatic channels or directly into the blood, and thus causes the symptoms of thyroidism which are intermittent in that they cease at least in the early stages of the disturbance, if the apparently exciting factors can be relieved. It is out of place to introduce the pathology and treatment of this condition here, but it is necessary to do so for the sake of clearness, in order to point out the apparent significance of this form of goitre and its relation to others.

If the patients who present a localized, circumscribed tumor of the thyroid with intermittent thyroidism, are given the antithyroid serum the symptoms will generally be relieved for the time being, but the tumor will not appreciably change, and marked general prostration will follow. Extirpation of the diseased area, however, will cure the whole disturbance except the muscular weakness, which will persist indefinitely unless some form of thyroid feeding is pursued or unless the normal remaining residue of gland hypertrophies. These two circumstances—namely, the apparent necessity of thyroid feeding to shorten the convalescence or to establish it, and the seeming prevention of recurrence or of goitrous hypertrophy of the rest of the organ by thyroid feeding, are very suggestive of an original over-activity of the thyroid which is compensatory to some nutritional failure. It is probably nutritional because of the seeming great variety of exciting causes, in all of which a common denominator can more readily be found in an error of nutrition rather than in any other one disturbance.

Another very important matter to note is the histological structure of these diseased areas or " leaking retention cysts." The tumor may show the ordinary multiple cystic degeneration, but in some part or parts, often at the periphery, there will be found the changes which are characteristic of the abnormal thyroid of typical Graves' disease. These changes are not found in the simple goitres which are unaccompanied by systemic disturbance.

The hypertrophy of an organ for some failure or deficiency in its own or another's function is too familiar to need discussion, and the histories and progress of the cases of the exophthalmic and the more common simple goitres described above all suggest an enlargement compensatory to some general requirement which seems connected with nutrition. It is probable, however, that some goitres may represent a compensation of a slightly different but still closely allied character, as it seems connected with the metabolism or body chemistry of the element iodine. There is no evidence that any other element enters into the problem, although there are popular prejudices which connect the prevalence of goitre in certain localities with the presence of calcium in such regions.

Long before iodothyrine was isolated as a supposed active constituent of the thyroid, iodine in one form or another was found to affect patients with thyroidal disorders. Some goitres under its administration will disappear,—less often they enlarge. In cases of thyroidism, however, it is usual to find that eventually all the symptoms are made worse and the enlargement of the thyroid greater, although at first iodine may seem beneficial. The clinical experience—namely, that the administration of iodine may cause an already hypertrophied thyroid to still further enlarge—alone is strong evidence that an excess of this element in the water or food may be an important factor in the production of goitre; also it is conceivable that a deficiency in the ingested iodine might lead to a hypertrophy of a conversely compensatory nature. The common kind of goitre, however, at least in the region of New York, seems to arise as a more generalized form of disturbance, and in the history and symptomatology indicates an attempt at compensation for what appears to be a failure in complex nutritional processes. What these may be remains to be studied.

PATHOLOGICAL ANATOMY.

The lesions associated with and complicating thyroidism have been found to involve almost every other organ in the body, and include a persistent or enlarged thymus gland and hypertrophy of the pituitary, and have been analyzed many times without throwing light on the mechanism of the primary disturbance. The changes in the thyroid itself, however, require some mention. It is still a matter of dispute as to whether or not there are constant histological and chemical changes in the thyroids of patients who suffer from the symptoms of Graves' disease. The alveoli of the gland in the fully developed and active stages of the disorder show chiefly infolding and reduplication or multiplication of the epithelial wall and basement membrane, which may go on to such an extent as to entirely fill some or all of the alveoli to the exclusion of the usual colloid. More or less of this condition seems always to be present in cases which give the usual signs of thyroidism, and the intensity of the symptoms coincides with the increase of the epithelium. The colloid material also stains less intensely than that in the normal gland. The chemical analysis of the iodine content of the gland has in the past shown great variations, but some recent determinations by Riggs and Beebe,[1] and Riggs,[2] show that error in the analytical processes explains the discrepancies. By the latest analysis by Riggs and Beebe [1] the amount of iodine to the gramme of gland seems generally to decrease in direct proportion to the severity of the symptoms of thyroidism, and this in conjunction with the well known susceptibility of these patients to the ingestion of iodine (and they are generally injured by it) is very suggestive. It is possible, therefore, that the ultimate causation of exophthalmic goitre lies in some vital or biochemical defect of the thyroidal epithelium which concerns the ability of the gland properly to take up and utilize iodine. This does not explain the evident connection of the thyroid with other organs nor the mechanism of the disturbance and how it may be remedied; but considered in connection with the cases described above, of "leaking retention cysts" of the thyroid, in which part of the gland is normal, and the cases of typical exophthalmic goitre which can be cured by removal of half the thyroid, there is a strong hint that both the quality and the quantity of the secretion are important in the constitutional disturbance. There are many cases of goitre in which one lobe of the thyroid appears normal while the other lobe is three times larger and the patient, while quiescent, shows no signs of thyroidism. But if excitement or fatigue are introduced the enlarged portion of the gland evidently swells, and coincidentally there occur tachycardia, dyspnœa, "nervousness," and weakness which may gradually subside when repose is enforced. Removal of the enlarged and degenerated lobe stops these attacks. Examination of the excised tissue shows that the mass of secreting epithelium and colloid is of course greater than normal; but in my experience there is always present, as mentioned before, some of the structure characteristic of Graves' disease, and the laboratory has regularly reported a percentage of iodine below that of the average healthy gland.

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[1] Personal communication.

[2] Jour. Am. Chem. Soc., vol. xxxi, No. 6, June, 1909.

In thyroidism, therefore, an increased quantity of secretion is evidently present, and with this there is some evidence that a gradual or rapid deterioration in the quality of the thyroid secretion may play a very important part in the continuation and progress of the pathological process.

REMEDIES WHICH HAVE BEEN FOUND EFFECTUAL IN RELIEVING OR MODIFYING SYMPTOMS.

Good hygienic conditions and, above all, mental and physical quiet are so evidently necessary in the treatment of all the symptoms associated with goitre that the importance of fatigue—especially nervous fatigue, which is an unsatisfactorily vague term—is strongly emphasized in the etiology of the disturbance connected with hypertrophy of the thyroid.

Of the remedies which may be called specific, in that they are designed to affect some one organ supposed to be at fault, the element iodine has already been mentioned. Some cases of simple goitre and a few of thyroidism may be made to improve or even recover entirely with this substance alone; but more frequently, after an apparent initial improvement there will follow an equally apparent injurious effect which will be accompanied by enlargement and hardening of the gland and generally gastro-enteric disturbances.

THE SPECIFIC ANTITHYROID SERUM AND THE THYROID PROTEIDS OR ACTIVE CONSTITUENTS OF THE GLAND.

The preparation of this substance and the reasons for believing the antithyroid serum a specific for inhibiting the functional activity of the thyroid gland without directly affecting any other organs, are described in an article on this subject in the *Archives of Internal Medicine* for November, 1909, by Dr. Beebe and myself.

The pure proteids of the gland are made somewhat as follows: The hashed-up fresh gland is extracted in normal salt solution for a week, then strained through gauze and the filtrate treated with dilute acetic acid which is supposed to precipitate the thyroid nucleoproteid material. The supernatant liquid is then poured or filtered off and half saturated with ammonium sulphate, resulting in a precipitate of the thyroid globulin which is approximately the colloid or fully formed normal thyroid secretion. The acetic acid or nucleoproteid precipitate and the ammonium sulphate or globulin precipitate can be dried and given by mouth or redissolved in an aseptic condition suitable for hypodermatic administration. The antithyroid serum is made by injecting rabbits or sheep with these combined proteids at intervals of five to seven days for several weeks. The blood of the animal thus "immunized" to the thyroid proteids is then drawn from the carotid and the serum separated and tested for its potency. It is then put up in sealed glass tubes each containing from one-half a cubic centimetre to 2 c.c., according to the potency or activity of the serum.

Dr. Beebe, my co-laborer in this field, has prepared all these substances, and I have had nothing directly to do with the chemical and biological problems involved. He informs me that neither the acetic acid nor the ammonium sulphate precipitate is entirely free from the thyroid globulin or thyroid nucleoproteid; in other words, the "pureness" of these proteids is only relative, and while the nucleoproteid or globulin predominates in their respective precipitates, neither precipitate is without some admixture with the other. Furthermore, Dr. Beebe is uncertain as to the chemical and physiological properties of these proteids, except that the nucleoproteid may contain a little more iodine than the thyroid globulin. The chemical properties may be closely allied, but I believe the physiological difference between these proteids is considerable and very important and more far reaching in its bearing upon disease in general and especially upon the so-called autointoxications than the profession and the physiologists appreciate.

Certain observations upon the histological changes in the thyroid glands of Graves' disease are suggestive of the physiological difference between the nucleoproteid and the globulin or colloid matter. The more acute and intense are the symptoms of Graves' disease the more epithelial cells and nuclei and the less colloid do the alveoli of the patient's thyroid show. In other words, the increase in the elements which yield the nucleoproteid material seem to bear a direct proportion to the severity of the tachycardia and general toxæmia. Moreover, these glands which show an active proliferation of the epithelium and a great deal of disintegrated cell material and very little colloid, supply a large nucleoproteid precipitate with acetic acid and very little globulin or ammonium sulphate precipitate. The gland from a normal individual exhibits the opposite characteristics and yields a much greater ammonium sulphate than acetic acid precipitate. These differences between the normal organ and one obtained from a patient who has died from the toxæmia of exophthalmic goitre invite a belief that the alveoli which are filled with disintegrating and incompletely formed cells and their nuclei, excite symptoms differing from those produced by alveoli in which the cells are fewer and the colloid much more abundant. Some of the difference probably depends upon abnormality in the cells, as in a case of myxœdematoid type the administration of the nucleoproteid material from a pathological gland will immediately excite the characteristic Graves' disease symptoms, especially the tachycardia; but the same symptoms can be brought out in such a case by a slightly larger dose of the nucleoproteid obtained from a normal gland. With this introduction the apparent differences in the physiological action of the thyroid nucleoproteid and the thyroid globulin are indicated below. These substances were administered to patients suffering not only with thyroid disease but also with a great variety of other pathological conditions, and much valuable information was thus obtained. Incidentally it is well known that throughout medical literature there are scattered undoubtedly honest reports of benefit from thyroidal feeding in a great variety of pathological conditions, and one of the most recent and remarkable of these reports is upon the result of such treatment in certain skin disorders by Johnston and Schwarz in the "Transactions of the International Congress of Dermatologists" of 1907.

The proteids obtained from sheep thyroids were first employed hypodermically, and their initial effects were quite constant; but in the course of days or weeks the dosage had to be greatly increased in order to accelerate the pulse or to raise the specific gravity of the urine, which were the gross changes looked for in patients not supposed to have any thyroid derangement. Those who might have a myxœdema taint in their symptoms were extremely susceptible to these proteids, but gradually lost this susceptibility; in other words, the dosage had to be increased to maintain the benefit sometimes apparent. But in continuing and increasing the dose, a few of these (cancer, myxœdema, and epileptic) cases showed very peculiar nervous and psychical symptoms—such as ataxia, disturbances of sensation, and transient mild delusions or even slight delirium.

In discussing these unpleasant experiences with Dr. Beebe he suggested that sheep thyroid, being a foreign proteid, when injected into man might gradually produce an antibody or an immunity, and hence in its continued use (the length of time varying in different persons) the foreign proteid might become useless or even harmful. When given by mouth these foreign proteids, however, seem to excite no immunity, and theoretically they should not. Hence in the subcutaneous administration of the "pure" thyroid proteids, after the above experiences we have always used those obtained from the normal human gland. Those which are fresh and obtained from subjects free from disease are alone employed, and this generally means a fairly young individual who has suffered death by violence, generally a murder or suicide. The acetic acid precipitate or the nucleoproteid portion of such a gland is scanty; the ammonium sulphate precipitate or thyroid globulin or colloid is fortunately more abundant. Dr. Beebe has prepared the nucleoproteid and thyroglobulin precipitates in a 1 : 1000 solution for hypodermatic use,—and bearing in mind that neither solution is entirely free from the other, noteworthy physiologic differences can be detected in their effect upon the heart and nervous system, especially in an individual who has passed through the active stages of Graves' disease and while still retaining some of the tachycardia and nervous irritability, shows the dry peculiarly colored skin of myxœdema with its puffy face, irregular digestion, supraclavicular fatty pads and weakness. A person without manifest thyroid disease, like an inoperable cancer subject or an epileptic, is not nearly as susceptible to these proteids; but when the dosage is raised and pushed, differences like those in the thyroidal cases are apparent.

As elements to be mentioned below may confuse the understanding of the apparent physiologic action of these two substances, their effects on the presumably normal subjects only will be described. In these a five (5) minim injection of the nucleoproteid solution once in four hours will elevate the pulse rate and induce insomnia and a feeling of nervousness within one or two days. A similar dose of the thyroglobulin solution gives an entirely negative result. The concentration of the thyroglobulin furnished me by Dr. Beebe can be increased to 1 : 100, and in this strength a five (5) minim dose at four hour intervals may in some normal individuals produce tachycardia and nervousness; but usually not. In cases of ulcerated carcinoma with inflammation and pain the nucleoproteid solution does not relieve the pain and inflammation and does cause tachycardia, breathlessess, weakness, and nervousness. On the other hand, ten times this strength of the normal human thyroid globulin, or a 1 : 100 solution can be given constantly and for weeks to a patient—for example, with an ulcerated carcinoma of the pharynx accompanied by bacterial infection of the neck—and there will be no ill effects upon the heart or nervous system and there will be noticeable relief of the infection. This experiment can be repeated upon surgical patients with wounds open to infection, such as those about the mouth, bladder, prostate or rectum, and while the rule has exceptions, the thyroid globulin solution appears to promote healing and prevent infection without the least ill effect. The thyroid nucleoproteid solution appears to have little or none of this beneficial effect upon the mechanism of resistance, and does cause unpleasant cardiac and nervous disturbances which are so closely analogous to the symptoms in Graves' disease as to almost force the conclusion that they are due to the same cause—namely, an excess of thyroid nucleoproteid in the circulation.

It is not out of place to note incidentally some of the conditions in which these substances have seemed beneficial, especially as they suggest the physiology of the thyroid gland for which an hypothesis is to be offered. In addition to its apparent use in increasing the powers of resistance the thyroid globulin solution also seems to have some beneficial effect upon the prolonged vomiting, fermentation and constipation which occasionally follows ether anæsthesia. The nucleoproteid solution seems in this condition useless or harmful. In one case of vomiting of pregnancy which threatened suppression of urine and eclampsia, the 1 : 100 thyroid globulin solution in forty-minim doses every four to six hours was given for weeks with most striking benefit upon all the symptoms and no ill effect whatever. It was suggested in this patient because she had recovered from Graves' disease under antiserum treatment months previous to the pregnancy. The 1 : 1000 nucleoproteid solution, on the other hand, was tried at the outset and stopped because of its tendency to excite tachycardia, weakness and nervousness.[3] Enough, however, has been said in the above to show the apparent difference in the effect upon presumably normal individuals between the thyroid nucleoproteid and the thyroid globulin solutions and also the extraordinary number of conditions as indicated by clinical symptoms, which seem to be influenced favorably by the thyroid globulin. These same differences in effect, though to a less marked degree, are noticeable when the thyroid nucleoproteid and thyroid globulin are given in dried form by mouth. In this form of administration the products obtained from sheep and pig glands have been mostly used. The thyroid nucleoproteid, therefore, in whatever way it is administered, seems limited in its effect first to increasing the rapidity of the heart action, then that of respiration, and if pushed further it induces a subjective feeling of weakness and nervousness. In all this there is a strong presumption that the nucleoproteid of the thyroid has a direct stimulant influence upon the sympathetic system in general and upon the cardio-accelerator nerve in particular. The thyroid globulin apparently does not participate in this. When given by mouth, however, in an unprotected form, it must be remembered that all organic bodies which partake of the nature of a "hormone" (Starling's designation of any substance or secretion serving as a chemical activant for some other secretion or organ), may be destroyed and rendered inert by the stomach digestion. To this rule the thyroid nucleoproteid seems to be a rather remarkable exception, for its effects are marked and constant, no matter how it is introduced into the system. The thyroid globulin, when swallowed in solution or dried form, appears entirely or almost entirely, inert, and what little effect results can be ascribed to the traces of the thyroid nucleoproteid which cannot as yet be entirely excluded from the preparation. To obviate the difficulty these and the other organic substances to be mentioned below, have been administered by rectum in cocoa butter suppositories, or by mouth after being encased in capsules which are then coated with melted salol and afterwards with a solution of keratine. Capsules thus covered must be encased in another capsule to prevent loss of the protecting cover by chipping or abrasion. The average dose of the thyroid nucleoproteid given by either of these methods is about one-fiftieth of a grain, but the effects of its administration in this way presents a noticeable difference from that produced by the subcutaneous use of the human thyroglobulin. The latter in excessive dosage up to thirty (30) or forty (40) minims of a 1 : 100 solution given hypodermatically every four hours to individuals without manifest or acknowledged thyroid disease, will produce some tachycardia, insomnia, and a subjective feeling of nervousness. This has always caused a cessation of the subcutaneous administration of the thyroglobulin, and it has not been pushed further; but the rectal use of the substance has not given such warnings, and in several instances the dosage has been increased up to one-tenth or one-fourth grain once or twice daily. This almost invariably will result first in producing light-, then clay-colored stools, then constipation and headache, and if continued, pain, referred to the right hypochondrium, will follow, and this is generally accompanied by fever which may reach 103° or 104° F., and the liver will noticeably enlarge and may be felt a finger's breadth below the free border of the ribs. These symptoms are much more readily excited in cases which show traces of or irregular signs of thyroidism than in those who do not. As stated above, the subcutaneous administration of thyroglobulin does not produce these unpleasant and alarming symptoms or else the other symptoms of tachycardia and nervousness prevent a cautious investigator from going far enough to obtain them.

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[3] E. G. Ward, in Transactions of the American Gynecological Association, 1909.

The suggestion of the effect upon the liver of this very active constituent of the thyroid and the method by which it was obtained opens up a wide field of supposition and experimentation with the other ductless glands, and Dr. Beebe has supplied me with the nucleoproteid material of the pancreas, adrenal and liver which have been prepared in the same way as the thyroid nucleoproteid. 1 : 1000 solutions of the nucleoproteids of these organs for hypodermatic administration have also been employed, but to a much more limited extent. The ammonium sulphate or globulin precipitates have not been tried, as they were very scanty in amount and of doubtful effect. The nucleoproteid material from the liver, however, when given by mouth seemed entirely inert; when given hypodermatically it is decidedly laxative in carcinoma and epileptic cases, but no other influence on the organism could be detected. The liver globulin in the same class of cases seemed to produce a feeling of fulness in the head, some somnolence and a tendency to nose bleed, but there was no change in the blood pressure. As the nucleoproteid and globulins of the liver appeared to exert no influence over the symptoms in thyroidism they will not be referred to again. The nucleoproteids of the pancreas and adrenals, however, seem to be of great value.

The adrenal nucleoproteid differs from adrenalin in that it lowers instead of raises the blood pressure. When given to patients with Graves' disease who show a blood pressure of 130 to 150 or 160, the adrenal nucleoproteid will reduce this pressure within a few hours to 110 or lower. Ten minims of the 1 : 1000 solution administered hypodermatically every three or four hours shows the same efficiency as one-eighth grain of the dried product given by rectum or by mouth in protected capsules. It also has little or no vaso-constrictor effect. It is sometimes remarkably beneficial for the somewhat irregular forms of thyroidism with high tension pulse and for those who show more or less marked pigmentation of the skin. In the latter cases the best effects are usually obtained by a combination of the adrenal with the pancreas nucleoproteid. The commercial desiccated suprarenal powder generally increases the symptoms of thyroidism and in some instances, when given by rectum, seems to be a violent purgative. In overdose the adrenal nucleoproteid may increase the "nervousness" and produce diarrhœa.

The pancreas nucleoproteid has been employed chiefly in the dried form and given by rectum or by mouth in protected capsules, and in cases which show no signs of thyroidism it seems to produce even in comparatively large dosage, no effect other than very mild catharsis and headache. It has seemed beneficial for the glycosuria in some cases of surgical diabetic gangrene, especially when the solution of the human nucleoproteid is given hypodermatically. In thyroidism, however, the pancreas nucleoproteid generally appears to be a pronounced sedative and hypnotic; but there are as yet some unexplainable differences between this and the commercial products known as trypsin, holadin, pancreatin and pancreatic extract. When administered by rectum some one of these substances, generally the nucleoproteid or trypsin, will prove beneficial in allaying the nervous irritability, thumping heart and insomnia, while any of the others may seem to aggravate these symptoms.

CASE HISTORIES ILLUSTRATING THE RESULTS OF "SPECIFIC" REMEDIES IN DISEASED STATES ACCOMPANIED BY HYPERTROPHY OF THE THYROID.

To facilitate the understanding of the therapeutics these cases will be summarized and then repeated in more detail.

Case 335.—Mrs. D. presented what has been described as a "leaking retention cyst" of the thyroid with intermittent symptoms of Graves' disease. Excision of the tumor cured all the symptoms except the weakness, which disappeared under subsequent prothyroid treatment or thyroid feeding.

Case 1.—Miss F. presented typical exophthalmic goitre in the early stages which slowly but entirely disappeared after three injections of the antithyroid serum. A recurrence of the incipient symptoms four years later was cured by pancreas feeding.

Case 82.—Mrs. L. presented typical exophthalmic goitre in the chronic stage and was at first greatly improved and then made worse by the antiserum. Thyroid feeding or prothyroid treatment then became noticeably beneficial.

Case 126.—Mrs. P. presented typical exophthalmic goitre in the chronic stage. The symptoms were made much worse by the antiserum and by feeding the combined thyroid proteids and by iodine. A change to the human thyroid globulin given subcutaneously produced an immediate improvement and a complete cure after several months of treatment.

Case 114.—Mr. McG. presented atypical exophthalmic goitre in the late or myxœdematoid stage. Nothing relieved the symptoms except the administration of the human thyroid nucleoproteid subcutaneously.

Case 287.—Miss R. presented typical exophthalmic goitre in the chronic stage. No medication produced improvement. After ligation of the vessels there was an immediate improvement and a gradual return to a nearly normal condition. Later the administration of pancreas nucleoproteid by rectum seemed a valuable adjuvant in the convalescence. All other preparations of pancreas excite signs of thyroidism.

Case 210.—Miss C. presented typical exophthalmic goitre in the early stage. The antiserum produced some improvement. Excision of the more enlarged lobe and isthmus of the thyroid resulted in an apparently perfect cure at the end of one month.

Case 23.—Miss M. presented typical exophthalmic goitre with a general condition indistinguishable from the last case, and underwent (at the hands of another surgeon) an almost complete thyroidectomy. Death followed within twenty-four hours, apparently from an acute exacerbation of the pre-existing thyroidism. In the exacerbation the usual dose of antithyroid serum was given without the least effect.

Case 43.—Mr. C. presented typical exophthalmic goitre in the late chronic stage. The antithyroid serum and the thyroid proteids aggravated all the symptoms. The administration of iodine alone resulted in immediate relief and a complete cure within three months.

Case 120.— Mrs. G. presented typical exophthalmic goitre in the late chronic stage, with marked pigmentation of the skin and a blood pressure of 150 mm. Hg. The administration of the solution of human adrenal nuceloproteid subcutaneously relieved all symptoms and reduced the blood pressure from 150 to 110 mm. within thirty-six hours. Later the combination of the adrenal and pancreas nucleoproteids seemed more beneficial than the adrenal alone.

Case 315.—Miss B. presented unmistakable incipient exophthalmic goitre. Five grains of trypsin given by rectum reduced the pulse rate from 90 to 60 in one night. Later the combined thyroid proteids seemed more beneficial in the convalescence.

Case 151.—Mr. P. presented typical exophthalmic goitre in the chronic stage, with glycosuria. Excision of one lobe and the isthmus of the thyroid has cured all symptoms.

Case 192.—Dr. G. had had typical exophthalmic goitre and recovered completely with the exception of exophthalmos. Then severe diabetes appeared. The administration of the thyroid proteids was followed by an immediate increase of the glycosuria. Death occurred six months later from diabetes.

Case 43.—Miss B. recovered completely from typical exophthalmic goitre under the administration of the antiserum. Three years later she developed severe diabetes. A combination of strict diet with the administration of large doses of pancreas nucleoproteid by rectum and complete rest resulted in a disappearance of all symptoms. The resumption of work brought a recurrence of glycosuria; diabetic coma and death followed.

Glycosuria or diabetes has appeared in five cases in this series, and the only one which has survived for six months is Case 151, in whom two-thirds of the thyroid were excised.

These histories illustrate what are apparently different phases of the same general process and show how the pathological condition can be relieved or cured by different remedies which are specified in each instance in that that remedy alone is required.

(To be continued.)

TREATMENT OF DRY ARTHRITIS WITH INJECTION OF VASELINE.

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In the *Hospitalstidende,* No. lii, 1904, I related two cases of dry traumatic arthritis in the hip joint, where in 1902 I succeeded by the injection of sterilized yellow vaseline in completely restoring the function and in fully making to disappear the violent pain and intolerable creaking when walking. This satisfactory result has in both cases continued after the expiration of seven and nearly five and a half years respectively.

Regarding the extension and practicability which this simple treatment can be expected to get in the future, I expressed the sure expectation that the injection of vaseline would be of importance in the treatment of malum coxæ et genu senile, because the suffering, from an anatomical and pathogenetic view point, is often very like the dry traumatic arthritis in younger individuals, in whom I had obtained such good results.

On the other hand, I expressed myself reservedly concerning the use one could expect of injection of vaseline in the many other kinds of chronic arthritis which manifest themselves by pain and creaking and stiffness of the articulations—the uratic and rheumatic arthrites, arthritis deformans, the alterations remaining after acute infectious arthritis (the gonorrhœal in particular). This reservation was mostly due to the knowledge that Büdinger[1] had tried the method in such cases with very inferior result. At the same time I saw in the very small quantity of vaseline which Büdinger had injected in these cases a possible explanation of the bad results, and was of the opinion that it was still worth trying the method in selected cases of this kind, only with larger quantities of vaseline.

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[1] Konrad Büdinger: Die Behandlung chron-Arthroit und Vaselin-injetition. Wien. klin. Wochenschrift, 1904, No. xvii.

Since this first report I have treated 51 joints with the injection of vaseline, but I consider it right, as a basis for the conclusions which I am going to now state, to use only the cases treated up to January, 1908, the result of which I have been able to control at least 18 months. The number of these cases is 30, with 35 vaseline injections owing to 5 of the patients having had bilateral joint affection. I have divided these cases into two main groups, of which the first, consisting of 7 cases, comprises the *non-traumatic "dry" arthrites,* whether they are of rheumatic, uratic or unknown origin; while the last group comprises the *traumatic dry arthrites,* into which comes malum coxæ senile, together with 4 cases where vaseline has been injected in order to prevent ankylosis after arthrotomy and arthrectomy—23 cases in all.

GROUP I.—ARTHRITIS URICA AND ARTHRITIS DEFORMANS.

Synopsis of Cases.

CASE I.—Emma N., aged 59, farmer's wife. Admitted December 27, 1904; discharged, July 2, 1905.

History.—Seven years ago the patient, who had up to that time been well and borne four children, began to suffer from rheumatism in finger, shoulder, and knee joints. Some of the finger joints became deformed. When moving, grinding was felt in the shoulder and knee joint which was very painful.

Operation, January 21, 1905. Puncture of both knee joints. Out of each joint 5 to 6 c.cm. of turbid, yellow synovia was evacuated, in which numerous, whitish yellow fluff was found. Injection into each joint of 25 c.cm. vaselini flavi.

Course.—Temperature, January 22, 39.6 C. to 37.5 C.; January 23, 38.7 C. to 36.6 C. Temperature after that normal. For the first few days pain was severe in the right knee. February 5, the vaseline seems to have acted favorably in the left knee, which can now be moved without creaking. Pain, though somewhat decreased, is still felt in the right knee.

Result: medium.

CASE II.—P. A., spinster, aged 48. Admitted September 8, 1905; discharged, October 30, 1905.

History.—Delicate in her young days. No uratic symptoms. Her present illness began 15 to 16 years ago, when a sudden swelling of the right wrist developed. No temperature. Shortly afterwards one finger joint after the other was attacked. By degrees both wrist and elbow joints, shoulder and knee joints and lately the left hip joint became affected. Gout-like attacks of the first metatarsophalangeal joints occurred. The knees especially inconvenience her.

Objective Examination.—Right shoulder ankylotic, left shoulder allows a little movement with grinding. Elbow joints are inflected, deformed. Wrist and finger joints also. Knee joints slightly inflected. The movements very limited. Creaking, pain, and swelling heavy. Effaced contours.

Operation.—October 2, 1905. In ether narcosis. Puncture of both knee joints; no synovia found in either joint. Injection into each joint of 15 c.cm. vaselini flavi.

Course.—No rise in temperature. Some improvement in the mobility of the left knee. The right knee is, on the other hand, almost as painful as before the operation, but there is no grinding or creaking.

Result: slight amelioration.

CASE III.—Miss L., aged 52. Admitted October 1, 1905; discharged November 14, 1905. Private clinic.

History.—Quite well until the menopause set in at the age of 45. Then she began to suffer from rheumatism first in the feet then in the knees, especially after the patient four years ago had a feverous illness with pains in the right side of the abdomen and shortly after pneumonia. Arthritic changes in finger, elbow, and shoulder joints have developed rapidly. Asthmatic and a little cyanotic.

Objective Examination.—Systolic murmur. Left knee is kept slightly flexed, even little movements hurt badly. The right knee on the contrary can be moved without any pain and to about normal extent.

Operation.—October 3, 1905.—Local anæsthesia. Puncture of the left knee joint, from which 25 c.cm. of turbid, fluffy fluid is evacuated. Injection of 20 c.cm. vaselini flavi.

Course.—Only slight rise in temperature, 39.8 C., in the evening, but severe pain felt after the injection. The movements are so painful that it is considered advisable to apply an immobilizing bandage. The patient died later on in her home of an affection of the heart.

Result: bad.

CASE IV.—B. S., spinster, aged 36, schoolmistress. Admitted December 28, 1905; discharged February 25, 1906. Private clinic.

History.—Has suffered from bronchitis several times; the expectorate has been examined well for T. B. with negative result. Twelve months ago pains and a slight swelling of the right knee began. For this reason patient was kept in bed. Since then the creaking and pains when moving the knee have increased. She stands about and walks a good deal.

Objective Examination.—No accumulation in the joint. Extended soft creaking by movements.

Operation.—Ether narcosis, February 10, 1906. Puncture of the right knee from which no synovia can be pressed out. Injection of 20 c.cm. vaselini flavi.

Course.—Temperature December 30, 38.5 C. to 37.8 C. Heavy pains, swelling and strain of the joint occurred during the first three weeks and there was a slight rise in temperature; 38.1 C. to 37.4 C. in the evenings for a whole month. Treatment with epithema tepid, passive movements, and massage to finish up with. About three months after the walk was good and free from pain.

Result: good.

Remark.—The diagnosis doubtful (traumatic? uratic? tubercular?).

CASE V.—A. M., aged 49, hospital nurse. Admitted February 7, 1906; discharged February 28, 1906. Private clinic.

History.—Patient suffered from rheumatic fever at the age of 14, this lasted a week. For the last 5 or 6 years she has suffered pains in both hip joints, the left one in particular. The pains lessen at changes in the weather, and hurt badly when patient gets up to walk after sitting or lying down. Strong creaking is heard in the joints when the pains are felt.

Operation.—February 10, 1906, ether narcosis. Puncture of the capsule which has been uncovered by an incision. No synovial fluid. Injection of 20 c.cm. vaseline.

Course.—February 1, temperature 38 C. to 37.4 C. Otherwise no rise in temperature; no pains, but the treatment has caused no improvement in this case.

Result: nil.

Case VI.—H. P. N., aged 58, laborer. Admitted May 1, 1906; discharged August 2, 1906.

History.—Arthritis genus dext. and ankylosis; arthritis genus sin. sicca. Patient has suffered pains during the last five years in the right knee. He has kept it in splints for the last two years, and during this time full ankylosis has set in. In the last six months pains have commenced in the left knee. Strong creaking is noticed by movements which, by the by, can be done to rather a normal extent.

Operation.—May 9, 1906, resectio genu dext. Bony ankylosis between cond. int. fem. et tibiæ. No fluid, the cartilage gray, the remaining articular surface bluish red. Puncture of the left knee. No synovia. Injection of 15 Grammes vaselini flavi.

Course.—Bad pains and great swelling of the left knee. The temperature rose steadily until 39.5 C. On May 16 another puncture was performed, by which a good quantity of serous fluid, mixed with blood, and a little vaseline was removed. No microbes (microscopical examination and culture). May 23: Temperature normal. Discharged on August 2 and was then able to walk fairly well with a crutch or stick. Very little pain was felt in the left knee, which he moved freely.

Result: good.

Case VII.—Miss A. L., aged 31. Admitted March 20, 1907; discharged April 17, 1907.

History.—Patient has since her twenty-first year suffered from multiple joint affections which began with pains in the left elbow joint, followed by increasing restriction of the movability; after that the finger joints were attacked and both ankle joints in the same way. Four years ago pains began in both knees. The symptoms vary a good deal. Sometimes patient is quite unable to walk. Fever never stated. Hip and shoulder joints free.

Objective Examination.—The left elbow ankylosed in rectangular position. The finger joints show typical arthritis deformans. The right knee joint slightly inflected, can only be moved very little and with great creaking. Patella unshiftable; left patella a little shiftable. Otherwise proportions the same. Röntgen photo shows the articulation surfaces in both joints rough, with pointed tips.

Operation.—March 23. Puncture of both knees. From the right knee a good deal of turbid, bloody, serous fluid is evacuated; from the left one nothing. Injection of 15 c.cm. vaseline into each knee joint.

Course.—Temperature March 24, 38.4 C. to 37.3 C.; March 25, 38.4 C. to 38.1 C.; March 27, 38.5 C. to 38 C. Severe tension of the left knee, why puncture is performed once more, and a good deal of vaseline and fluid comes out. Temperature after that normal. April 17, patient discharged. The walk very bad, hardly any better than before the operation.

Result: bad.

If we now, first of all, examine this group of cases—seven in number—whose history of illness is presented briefly in Group I, we can at once see by the results recorded, how mediocre or bad the injections of vaseline have acted in the majority of cases: Cases I, II, III, V, and VII. In some cases there appear besides severe pain, great swelling and expansion of the joint capsule, also symptoms of fever; in short, signs of an acute state of inflammation which vanishes in the course of few days or a week.

If the patient then gets up and begins to walk about, his condition is as a rule quite as it was before the operation; in some cases the patient is slightly better, but in others the walk has become even more painful than before.

The reason of this circumstance soon became evident to me by observation and inspection of the joint during the operation. It appeared as it was, that even in the most creaking joints of this category there were by no means dryness and lack of synovia; on the contrary, an ample fluid existed, though never clear, more or less turbid, grayish, containing fluff and threads, microscopically numerous leucocytes; but in no case did I succeed in proving microbes.

In other words, the question in all these cases is about exudative processes of inflammation in the joint capsule, whether these are due to chemical irritation (uric acid, toxins) or yet unknown and not demonstrable microbes, and it is easily understood that the vaseline under these circumstances only acts as a foreign body, which further irritates the synovial membrane and leads to increased exudation. In any case, when *turbid fluid* flows out by the puncture, I do *not* advise the injection of vaseline.

Considerably more difficult is the question how to act in the minority of cases, where such arthritis seem finished with a creaking, painful joint, which is *deficient in synovia.* First, there is this difficulty,—that the differential diagnosis of the traumatic joint affection may be hard to make, if pronounced symptoms of inflammation have not appeared at an earlier stage of the disease, as in Cases IV and VI, where no synovia was found in the joint. As a rule the course after the injection of vaseline, exactly like the latter case, will give the diagnosis by a more or less severe return of the inflammation with high temperature, painful, strained swelling of the joint capsule, sometimes peri-articular œdema. But it is indeed too late, and an unfortunate way of finding the diagnosis, if the injection of vaseline was absolutely unnecessary or even injurious in such cases. I am not disinclined, however, to believe that the injection of vaseline in several cases of this sort is worth trying or experimenting with.

With two of these patients, the above mentioned Case IV, a school mistress, 36 years of age, and Case VI, a laborer, 58 years of age, I obtained in the end, after the tedious reaction had ceased, a really good functional result—almost normal mobility without creaking, and a strong leg, fit for use.

With another patient, Case V, where the disease formerly had had the appearance of a slight, rheumatic polyarthritis, but the puncture gave no fluid in the joint, the injection of vaseline seemed quite without any effect; but the reaction after the injection on the other hand was extremely slight, as the highest temperature was 38° C., and the pains not more considerable than they used to be every day.

The result of my experiments with the injection of vaseline in the case of really chronic apparently dry arthritis of uratic, rheumatic or other infectious origin has been as follows: *If by the puncture fluid is found in the joint, one ought to abstain* *from the vaseline treatment completely; if, however, the joint is found completely dry and the inflammation apparently extinct, one ought to attempt the injection of a smaller quantity of vaseline, which cannot distend or strain the capsule, afterwards carefully watching any possible return of the symptoms of inflammation.*

GROUP II.—MALUM SENILE AND OTHER FORMS OF DRY TRAUMATIC ARTHRITIS.

Synopsis of Cases.

CASE I (Published in the *Hospitalstidende,* 1904, No. lii).—Miss K., shop girl, aged 32. Admitted April 14, 1902; discharged April 29, 1902. Readmitted June 3, 1902; discharged June 16, 1902.

History.—Congenital left-sided hip luxation. Caput femoris displaced high up in fossa iliaca externa, expanding the gluteal muscles. For the last three to four years constant increased creaking and grinding in the joints when moving. You can hear it a long way off. August 6, 1900, operation. The capsule is opened by longitudinal incision. No synovia. Caput femoris greatly deformed; covered with pikes like a thornapple. The pike-covered calotte was removed with rounded kerf. Healing per primam. Temporary improvement, but at the end of the year the attacks were as bad as ever.

Operation.—April 14, 1902. Ten c.cm. of vaseline is injected without incision. April 22, soundless and painless walk lasted four weeks, then creaking and pains began once more. I thought that too small quantity of vaseline had been injected. June 6, 1902, the incision was made to the capsule and now under control of the eye, twenty-five c.cm. of vaseline flavi were injected into the joint cavity.

Result.—The result was excellent and has remained unchanged up to the present date (July 15, 1909), more than seven years,

CASE II.—(Published in the *Hospitalstidende,* 1904, No. lii.) I. (farmer), aged 25. Admitted March 21, 1904; discharged April 4, 1904.

History.—At the age of 16 right-sided coxitis healed up with ankylosis, after which his walk was lame but free from pain so that he was able to look after his farm, until 12 months ago, then pains and creaking began in his left hip; these have increased so that he is now quite unable to work. The right lower extremity 3½ cm. shorter than the left one. By passive movements strong osseous creaking is noticed in the left hip joint.

Operation.—March 24, 1904. Puncture of the left hip joint. No synovia. Injection of 20 c.cm. of vaseline.

Course.—No rise in temperature. March 28, 1904: He gets up and is able to walk without any pains or creaking. Patient has been capable of doing his work during the past five years.

Result: excellent.

CASE III.—N. C. L. (sailor), aged 22. Admitted December 8, 1904; discharged January 4, 1905.

History.—At the age of nine severe trauma of the right regio glutæalis caused by being upset out of a cart. After some time an abscess was formed and some bits of bone were discharged. The fistula closed quickly. Since then free motion but increased creaking in the right hip joint. Two months ago patient fell on board ship in bad weather and hurt his right hip badly. Since then heavy increased pains and creaking after movements, especially in the evening.

Objective Examination.—Healthy appearance, considerable atrophy of the muscles in the right gluteal region and on the right femur. By rotation and abduction heavy creaking (osseous) in the joint, but the movements are otherwise normal. No shortening of the extremity.

Operation.—December 22, 1904. An incision 5 c.cm. long is made above trochanter major, the capsule is exposed and punctured with a big trocar. No synovia is found. Direct from the tube 25 c.cm. of fresh sterilized vaseline is injected. The wound is joined with aluminium bronze covered with collodion and cotton wool.

Course.—December 29, 1904. The suture is removed. Healing without reaction. Patient gets up. January 4, 1905: Has been free from pains and creaking since the operation. Is up all day and feels absolutely well. Discharged.

Result: excellent.

Remark.—Information in October, 1906. Shortly after the discharge the patient enlisted at the board of conscription for the navy as a sailor and took part in all the hard training on board, till one day, when the surgeon heard that he had lately undergone an operation in his hip, he was sent to Professor Rovsing to inquire if he ought to be excused from service. This was advised. Since then patient has been perfectly strong and well.

Case IV.—S. L., married woman, aged 33. Admitted December 27, 1904; discharged January 16, 1905. Readmitted January 30, 1905; discharged February 5, 1905.

History.—No tubercular or other morbid disposition. Quite well until three years ago—when by a fall patient hurt her right knee. Since then she has felt pains and creaking every day, not much swelling. Patient has been kept in bed from time to time, but treatment with immobilization, tinct. iodi. spirit., cantharides, water cure has been in vain.

Objective Examination.—Strong, healthy appearance. No swelling of the right knee which measures exactly the same as the left one (35 and 32 cm.). No accumulation in the joint. She can move the knee to a full extent, but distant rather soft creaking and grinding is heard.

Operation.—December 29, 1904, ether narcosis. Puncture of the right knee joint. No fluid flows out. By strong compression a few drops of *clear* synovia is pressed out at last. Injection of 30 c.cm. yellow, sterile vaseline. Collodion and cotton wool dressing. Microscopy and culture from the drops of synovia show no microbes, no leucocytes. January 31, 1905: Second operation. Puncture, whereby 20 c.cm. of vaseline and a little thin synovia is removed.

Course.—The evening after the operation temperature was 38.2 C., and normal after that. After the injection the creaking vanished completely. January 5: Patient gets up and walks by the aid of a stick. Tension and pains in the knee when moving. Discharged. January 15: Comes back again. The right knee swollen, 3 cm. bigger than the left one. Bursa subcrurea is particularly strained, fluctuating. No creaking. The knee can be extended fully, with good function, but only flexed till about 80° without pains. January 31, 1905: As it is certain that too much vaseline has been injected 20 c.cm. is removed. After that patient is completely free from pains. Discharged February 5, 1905.

Result: finally good.

Remark.—Injection of too much vaseline.

Case V.—V. H., a merchant's wife, aged 37. Admitted March 28, 1905; discharged April 22, 1905.

History.—By a fall 22 years ago patient hurt her left hip; felt pains for some months, but these passed away until 10 years ago when she noticed increasing weakness and stiffness of the left hip joint. Treatment with massage, electricity, douche, but all without any effect. Patient has used a stick during the last 12 months.

Objective Examination.—Movement free until about 60°, then she began to complain. Slight creaking is felt. She is very stout. Atrophy of 2 cm., but no shortening of the left lower extremity.

Operation.—After ineffective treatment with iodide of potassium and local steam baths, puncture was performed on April 18, 1905, without evacuation of synovia; and after that injection of 20 c.cm. vaselini flavi.

Steady improvement.

Result: medium.

Case VI.—P. H. (blacksmith), aged 24. Admitted April 11, 1905; discharged April 18, 1905. Private clinic.

History.—Three years ago patient dislocated his right shoulder while working hard in the field during harvest time. After a while pains and creaking developed. These were at their worst in the evening and improved by taking exercise. For six weeks treatment with immobilization without any effect. Heavy creaking in the right shoulder, some also in the left shoulder.

Operation.—April 14, 1907. Local cocain-anæsthesia. Puncture of the right shoulder joint, by the cannula being introduced exactly below acromion. No synovia flows out. Injection of 20 c.cm. of sterilized vaselini flavi.

Course.—April 18. No creaking, no pains, even when moving a great deal. Patient has been well ever since.

Result: good.

Case VII.—H. N. (farmer), aged 55. Admitted July 3, 1905; discharged July 17, 1905. Private clinic.

History.—Quite well until five or six years ago, when he began to feel pains in both knees; especially while standing. Pains have increased gradually since then and during the last three or four years strong creaking has begun in his left knee joint especially. Now he is quite unable to work. No swelling in the knee regions. Strong creaking in both joints. The right one can only be flexed to a right angle. On the right side a corpus liberum is supposed to exist. Patient does not wish arthrotomy.

Operation.—July 6, 1905. Puncture of both knee joints, by which no synovia can be removed. Injection into each joint of 15 c.cm. vaselini flavi. July 7: No creaking—no pains. July 10: Temperature normal, patient gets up. July 17: Able to walk quite well without pains. Discharged.

Course.—No reaction.

Result: satisfactory.

Diagnosis: Malum senile.

CASE VIII.—A. J. (farmer), aged 76. Admitted July 26, 1905; discharged August 7, 1905. Private clinic.

History.—Ten years ago symptoms of malum senile began in both hip joints and both knee joints. These symptoms have increased gradually and during the last six months patient has had to walk with a stick or a crutch. Movability decreased, bad pains, but only inferior creaking in the hip and knee joints. The knees worry patient the most, consequently he wishes for treatment of these only.

Operation.—July 28, 1905. Puncture of both knee joints. No synovia can be pressed out. Injection of 15 c.cm. sterilized vaseline into each knee.

Course.—The evening of the operation temperature rose to 38.5 C.; after that it was normal. August 2: No pains, no creaking by passive movements. Patient gets up. August 4: His walk much improved without any pains in the knees. August 7: Patient thinks walking much easier, and is delighted with result.

Result: good.

CASE IX.—A. K. (spinster), aged 70. Admitted September 8, 1905; discharged October 2, 1905.

History.—Patient well until two or three years ago when she began to feel bad pains in the right hip-joint when moving. These pains have increased gradually since then. She is only able to walk with a stick and bends forwards very much.

Objective Examination.—Great atrophy of the right femur, which differs 5 cm. from the left. Movements very painful, producing bad creaking. Position adducted and inflected.

Operation.—September 15, 1905. Primary ether narcosis. Puncture of the right hip joint through the capsule exposed by incision. Not one drop of synovia flows out. One feels the articulating surfaces creaking against each other. Injection of 20 cm. of vaseline.

Course.—No rise in temperature. No pains after the injection. September 21: Patient gets up. September 24: Patient walks about without any pains. October 2: No pains, no creaking while walking.

Result: excellent.

Case X.—Miss H., aged 30. Admitted October 7, 1905; discharged November 15, 1905.

History.—Kyphoscoliosis since the age of four, with shortness of breath, palpitation of the heart, etc. For the last ten years pains in the left jaw joint when moving it. Also increasing creaking and grinding which greatly inconveniences the patient.

Objective Examination.—Creaking and pains when moving the left jaw joint. No swelling. The Röntgen photo shows nothing abnormal.

Operation.—October 18. Local cocain anæsthesia. Incision to the capsule. Puncture of the lowest articulation chamber of the left joint. No synovia found. Injection of 1–2 cm. vaseline. October 30: Injection of vaseline in the uppermost articulation chamber.

Course.—Creaking even after the operation. Pains the first few days, after that the pains and creaking decrease considerably. Patient discharged, greatly improved.

Result: medium.

Case XI.—S. S. (married), blacksmith, aged 62. Admitted November 24, 1905; discharged December 14, 1905.

History.—Patient quite well until six years ago when he began to suffer pains in both shoulder joints and over arms. Two month ago he fell and hurt the right shoulder joint, whereby the movability was further restricted and the pains increased.

Objective Examination.—No swelling or deformity in the shoulder regions. Bad pains and creaking by movements. Röntgen photo shows the surface of cavitas glenoidalis somewhat rough.

Operation.—December 5, 1905. Ether narcosis. Puncture of both shoulder joints below the hindmost corner of acromion. No synovia is found in either joint. Injection of vaseline: 15 cm. in the left, 20 cm. in the right shoulder joint.

Course—December 6: Temperature 38° C. to 37.3° C. Pains in both shoulder joints. After that no fever, no pains. December 8: Patient gets up. December 9: Movements free. No creaking. December 12: Patient can swing his arms without any pains.

Result: excellent.

CASE XII.—K. M. C. (married), aged —, farmer's wife. Admitted November 5, 1905; discharged December 6, 1905.

History.—Increasing pains in the right hip during the last four years. Patient has alternately been kept in bed and walked about with crutches. She was emaciated greatly.

Objective Examination.—The movements of the hip cause great pain, and pelvis moves then too. Two cm. atrophy of the right femur. The Röntgen photo shows no destruction. Inferior creaking.

Operation.—November 18. Ether narcosis. Incision. Puncture. No Synovia. Injection of 20–25 c.cm. of vaseline. Suture.

Course.—Excellent effect. November 23: No pains felt in the hip when moving it; it acts freely. December 1: Walk painless and natural.

Result: excellent.

CASE XIII.—P. P. (farmer), aged 34. Admitted January 8, 1906; discharged February 12, 1906. Readmitted January 26, 1907; discharged February 16, 1907.

History.—Patient has congenital bilateral hip luxation. Waddling but painless walk until he was 25 years old, then bad pains began in his right hip. During the last three years pains in both hips when walking. Ineffective treatment with salicyle, immovable bandage and leather corset, in order to keep the head of the thigh bone down—all this only causes pressure and pains. Trochanter situated 5 cm. above Roser-Nelaton's line on both sides. Whenever the patient moves creaking is heard in both hip joints.

Operation.—January 11, 1906. Ether narcosis. Puncture of the right hip joint. A little clear synovia is found. Injection of 25 c.cm. vaseline.

Course.—Excellent effect; but pains in the left hip joint are getting worse; so the patient returns on January 26, 1907. January 30, 1907: Puncture of the left hip joint. Injection of 25 c.cm. vaseline.

Result: splendid.

Case XIV.—Mrs. J., aged 66. Admitted August 10, 1906; discharged August 24, 1906.

History.—Malum coxæ dextræ senile, began three years ago. The patient gives the impression of being rather senile. Creaking and grinding is felt in the right hip, which passively can be extended fully. Ineffective treatment with massage, cauterizations, etc. Röntgen photo proves irregular contours of the lowest half of caput.

Operation.—August 17, 1906. Local cocaine anæsthesia. Puncture of the left hip joint. No synovia found. Injection of 20 c.cm. vaselini flavi.

Course—Splendid effect. August 21: Patient gets up and is able to walk without any pains and without grinding.

Result: excellent.

Case XV.—K. M. N. (farmer's wife), aged 45. Admitted October 4, 1905; discharged January 20, 1906.

History.—Patient, who has a lot of hard work standing up, and who had suffered a long time from nephroptosis, began during the last few years to complain of pains in her right knee while walking and standing. Some creaking noticed latterly. No visible accumulation, no swelling of the capsule, only a good deal of creaking.

Operation.—October 18, 1905. Puncture of the right knee. In spite of hard massage and exercise of the knee not one drop of synovia is found. Injection of 25 grammes vaselini flavi.

Course.—October 19: No pains, but the following week a good deal of tension in the knee. Suppose that too much vaseline has been injected. Massage and strong movements of the knee is tried. December 5, 1905: Patient leaves bed.

Result: medium.

Case XVI.—I. S. (coachman), aged 61. Admitted Oct. 31, 1906; discharged November 28, 1906.

History.—Patient never felt ill till three or four years ago when he began to suffer pains and lack of strength in the left hip region. His walk became very bad and during the last few months his right hip has suffered in the same way. Healthy appearance, very tall and thin. In both hip joints strong dry creaking is noticed when moving them to a normal extent. Röntgen photo shows indistinct rough contours of caput femoris on both sides.

Operation.—November 8. Ether narcosis. Puncture of the hip joints. Not one drop of synovia is found. Injection 15 c.cm. vaselini flavi.

Course.—No fever. Insignificant pain in the left hip—the right one quite free from pain and patient is able to move it freely. November 13: Patient gets up. Almost no creaking. Discharged feeling greatly better.

Result: good.

CASE XVII.—K.I. (married) farmer. Admitted January 11, 1907; discharged March 12, 1907.

History.—Arthritis traumatica sicca in the right shoulder. Five years ago patient was lifted up by a waterspout and thrown down into a ditch.

Operation.—January 26. Puncture of the right shoulder joint; no synovia found. Injection of 15 c.cm. vaseline.

Course.—No pains and no creaking in the shoulder joint after the injection.

Result: good.

CASE XVIII.—M. J. (surveyor), aged 42. Admitted February 23, 1905; discharged April 4, 1905.

History.—Arthritis, traumatica genus d. synovitis; chondritis dessecans. Multiple corpora libera cartilaginea. Patient dislocated his right knee in jumping over a ditch. Bad pains immediately after; they went away after a week's rest but returned a few months later. Since then his walk has been very painful; he feels creaking in the knee, which is often swollen. The furrows on each side of patella are diminished. Patient can bend the knee to a normal extent, with creaking.

Operation.—Ether narcosis. Arthrotomy along the inner edge of patella about 25 c.cm. of turbid tough synovia is evacuated. In the synovia is found many little flat bodies which remind one of broken bits of mother of pearl. Small loss of substance in the joint cartilage. The synovial membrane red, swollen. Irrigation with 4 per cent. carbolic water. Injection of 25 c.cm. vaseline after capsule was closed.

Course.—Healing per primam. During the first month or two rather bad pains are felt when moving the knee, but these vanished gradually and patient has obtained almost normal function.

Case XIX.—I. J. (farmer), aged 30. Admitted June 28, 1905; discharged July 12, 1905.

History.—A few years ago patient dislocated his left elbow when turning a plough. Since then he has felt uneasiness and increasing difficulty in stretching out his elbow, so that he cannot very well attend to his work. Besides pains there is creaking. No swelling of the capsule, the elbow can be flexed completely but only extended to 140°. Röntgen photo shows a heap of foreign bodies in the articulation, mostly on the flexor side.

Operation.—June 29, 1905. Ether narcosis. Arthrotomia cubiti sin. Plenty of synovia flows out, and at last come a heap of white hard, clinging corpucula aliena. By the aid of the curette more of these are removed. The cartilaginous area look as if pock-marked, with small loss of substance. Chondritis dessecans. Finally, injection of 10 c.cm. vaseline.

Course.—Patient much better but uneasiness is still felt, and the extension of the elbow is somewhat limited. Patient has been able to resume his work.

Result: rather good.

Case XX.—Miss K., aged 20. Admitted January 24, 1906; discharged April 21, 1906.

History.—Osteochondritis condyli externi femoris dextri. Three years ago patient felt pains and fatigue in the right knee joint. Was in bed for some time with hot water bandage; later on twice in five weeks immovable bandage. Bier treatment, etc. all ineffective. Case grew worse.

Objective Examination.—The leg is kept slightly flexed in the knee; can be bent actively to 90° without much pain. No accumulation. The circumference of the knee is 35 cm. on the round side. Atrophy of 2 cm. on the biggest place of femur and crus. Rather strong creaking by movements.

Operation.—January 28, 1906. Arthrotomia along the lateral edge of the right patella. There appears to be plenty of deep yellow but clear synovia. Condylus externus proves to be the seat of a strange osteochondritis, while the medial one-third of cond. ext. is covered with smooth normal cartilage, the cartilage on the outer two-thirds is quite uneven and changed. Across condylus a deep furrow, like a cicatrix, is found in the cartilage; this goes down into the bone for a bit, and here and there appear whitish knots and knobs in the smooth cartilage. The whole of the diseased part of the cartilage is removed with a sharp chisel. The tissue under this is softer than normal, and with curette a part (the size of a walnut), of soft diseased osseous tissue is removed. The remaining part of the articulation surface on cond. ext. is of such a size that sufficient surface against patella and tibia is left. After the bleeding is stopped the capsule wound is sutured and an injection of 20 c.cm. vaseline finally made to prevent ankylosis. Immobilizing dressing.

Course.—The patient's condition on June 17, 1907, almost 18 months after the operation is as follows: She can bend and stretch her knee to the full extent. No pain. Only now and then a soft rubbing is felt in the joint. She is able to dance and ride her bicycle, and there is no lameness.

Result: excellent.

CASE XXI.—C. J., aged 32. Admitted May 28, 1907; discharged July 13, 1907.

History.—Ankylosis art. talo cruralis, seq. fractura tali et malleoli int. Twenty-one months ago patient got badly injured by a fall. At the Kommune Hospital the diagnosis was fracture of malleol. extern. Treated with bandage for a week, followed by walking bandage for three weeks. Patient discharged after six weeks, but walked very badly then by the aid of two sticks. During the first nine months unfit for work owing to pains. The last 12 months he has been able to attend to it but complains of not being able to extend the foot, or to dorsal flex. Ankylosis in a inward rotated position. A prominent bone is felt in the angle between crus and talus.

Operation.—June 11, 1907. Ether narcosis. Incision from malleolus ext. to os cuboideum. No synovia is found in the joint. The prominent piece of bone proves to be a fragment of talus, which has been raised up in front of the articulation line, turned head over heels, so that the top of the articular surface turns downwards. Besides this another much bigger fragment of talus is found dislocated forwards and there fixed in callus matter. This is removed by chisel until the dorsal flection is free. The rest of talus is left. Suture and finally injection of vaseline.

Course.—The progress was quite without reaction. Jan. 30: Patient gets up and sits in a chair. She can move the foot actively and passively without pain. June 12: Is now able to walk with a stick.

Case XXII.—I. C. N. (grocer's wife), aged 41. Admitted July 27, 1907; discharged August 30, 1907.

History.—Quite well till eight years ago, when patient by degrees felt pains in the right hip joint without preceding considerable trauma. For the last few years patient has not been able to attend to her work in the shop. The pains disappear when lying down, but reappear when starting to walk. Creaking in the joint by movements. No distinct atrophy. Röntgen photo shows caput somewhat flattened, deformed.

Operation.—August 12, 1907. Ether narcosis. Incision is made through the skin, fascia and the muscles to the joint capsule. Puncture is performed. No synovia. Injection of 20 c.cm. of sterile yellow vaseline.

Course.—August 27: Patient gets up. Perfect recovery.

Case XXIII.—A. J. (stonecutter), aged 41. Admitted September 12, 1907; discharged September 29, 1907. Private clinic.

History.— At the age of 14 patient suddenly began to suffer pains in the left hip region. Treatment for three months with extension and confinement to bed; later on bandage. He got quite well after this and served his time in the army. Three years ago pains and creaking started, especially when going down steps; he often carries heavy burdens. Röntgen photo shows coxa vara.

Operation.—September 14, 1907. In Ether narcosis. The movements of the hip can be done rather easily. Incision through the skin and muscles to the capsule. Puncture. No synovia. Injection of 20 c.cm. vaseline.

Course.—Temperature 38.4° C. the first evening; after that, progress without any reaction.

Result: good.

If we now consider Group II, the *traumatic dry arthritis,* which comprises strictly my two cases previously published and 17 new ones, we find almost constantly such a very satisfactory effect of the vaseline treatment, that those anticipations I cherished with regard to it some time ago, where these forms of arthritis are concerned, can be said fully to be realized.

Here is evidently the real ground for the injection of vaseline, and this is in itself quite natural and obvious when we consider the nature of these diseases. Here is in fact no inflammation. Perhaps we have a formation of fibrous tissue, a fibrous alteration of the synovial membrane, but with the acute traumata this is due to the organization of the clots of blood, to the fibrine deposited on the synovial membrane. In the case of the more chronic traumata, as in the cases of congenital luxation of the hip joint, it is the consequences of the injuries, which by walking are constantly inflicted upon the synovial membrane itself, by pressure, friction, and dragging; and finally by malum senile it is the arteriosclerotic, the senil-atrophic processes, which bring on the fibrous degeneration in the synovial membrane by which the synovia-producing qualities of the same are reduced or extinguished.

By the disappearance of the synovia the surfaces of the bones are left unprotected against pressure and friction and now the usura, the gnawing of the cartilage is beginning, which ends in more or less extended denudation of the bone, and we get the clinical picture of osteo-arthritis. But it is no inflammation really, only the consequences of the absence of synovia in the joint, and to replace the synovia with the vaseline is, in a word, the object of my treatment.

If we now consider these 17 cases of dry traumatic arthritis further, we find 2 patients with congenital luxation of the hip—Cases I and XIII. Case I is that patient who first made me try the vaseline treatment.

In that case the severe pain and the violent creaking, which the deformed, thornapple-like caput femoris produced when walking, completely vanished after the injection of 25 c.cm. of vaseline. Most important it is that this result has now lasted unchanged for *seven* years, the operation having taken place June 6, 1902. While the patient in this case was a woman, 32 years old, with one-sided luxation of the hip, Case XIII is a man, 34 years old, with *double-sided congenital luxation of the hip.* He likewise suffered greatly and was quite unable to work; in his case also the injection of vaseline has had the same excellent effect.

In Case II (also published before) a farmer, 25 years old, the disease was due to chronic overpressure of the left hip, in consequence of a tuberculous coxitis on the right side healed up with ankylosis. The man who was completely unable to work has been well ever since. Together with these three cases still two may be classified, Cases XXII and XXIII, where daily traumatic abuse by overloaded or overworked middle-aged persons produced a dry, creaking arthritis in the hip joint, which was cured at once by the injection of vaseline.

A new but kindred group form 7 cases of malum senile (Cases VII, VIII, IX, XI, XII, XIV and XVI). In Cases VII and VIII it was the two knee joints, in Case XI both shoulder joints of a blacksmith, in the other cases the hip joints, where malum senile was localized.

I stated in my first article, that the injection of vaseline would be expected to have an excellent effect in this disease, which from a pathologico-anatomical view had a likeness to the joint affection described before. This has to a great extent proved to be true, because in one and all of these cases the effect has been excellent and so to speak instantaneous.

In the rest of the 19 cases the question is about dry arthritis, which has developed in accession to all acute trauma, in all probability consequent to the organization of clots of blood deposited on the inner side of the synovial membrane, and by the fibrous alterations of the membrane the synovia-producing ability of the same has been spoiled.

Among these cases we find represented besides the shoulder joint (Cases VI and XVII), the hip joint (Cases III and V), the knee joint (Case IV), and in *one* case (Case X) the jaw joint.

Among these, Case III is a good example of how much can be obtained by this simple treatment. It was a sailor, 22 years old, in whom a dry, creaking and painful right-sided coxitis had developed after repeated strong traumata. After the injection of 20 c.cm. of vaseline all symptoms of disease disappeared at once; he could walk without any pain or inconvenience on the sixth day after the operation when he got up, and felt so well that, unknown to me, he enlisted at the board of conscription for the navy, and without any inconvenience went through the fatiguing training for several months, until the military surgeon one day by chance discovered the scar from the operation.

In Cases IV, VI and XVII a splendid result was obtained. In Case X after the injection of vaseline first in one then in the other joint chamber of the left jaw joint, a great improvement in the condition followed. Only in Case V, the result was inferior, unknown by what reason. It is possible that the case has not been traumatic arthritis. The trauma had here taken place 22 years ago, while the patient stated that the joint affection in her left hip had commenced only 10 years ago; added to this is that her habitus and antecedentia made me suspect uric arthritis. Another possibility is, that the puncture and the injection, which was performed without an incision to the capsule, may have lost its way and completely or partly happened extracapsular.

To these 19 cases of the injection of vaseline in dry traumatic arthritis a special group of 4 cases belongs (including Cases XVIII to XXI), where the vaseline injection has been given *prophylactically* to prevent ankylosis or stiffness of the joint after arthrotomy or arthrectomy.

In the two first cases the question is about that most interesting joint affection following a traumatic injury,—in both these cases a severe distortion of respectively knee and elbow, where a peculiar disease of the joint cartilage is developing, called by a name not at all appropriate, " chondritis dessecans." It is characterized by the following: Round about on its surface little round cartilaginous lamina are burst off, and then accumulated in small heaps, like corpora aliena, in the nooks and corners of the joint, leaving little smallpox-like loss of substance in the joint cartilage. These little bodies are round or oval, flat or convexo-concave, reminding one of the little broken bits of mother-of-pearl one often finds on the inside of mussel and oyster shells.

In both these cases arthrotomy was performed; the corpora aliena were removed by the aid of a little spoon and irrigation. The capsule wound was joined with suture. But just before this was completed, vaseline was injected in the articulation. Patient XVIII (knee joint) has recovered completely and the recovery has now lasted four years; the other patient, whose left elbow joint was operated on, cannot stretch his elbow to full extent, and complains at times of uneasiness in the articulation, yet he has been able to resume his work as a farmer, and one must say that his condition is wonderfully improved.

In Cases XX and XXI the question is about partial joint resections, which were completed with the injection of vaseline in order to prevent ankylosis. This has been a success in both cases.

The first of these cases was a young lady, 20 years old, with osteochondritis in condylus externus femoris of doubtful origin. The outer two-thirds of the condylus externus had to be removed completely. Just before the last capsule suture was tied, 20 c.cm. of vaseline were injected in the joint. The result was excellent. The patient is now, eighteen months after the operation, able to bend and stretch her knee to the *full extent without any pains.* She can ride her bicycle and walks not at all lame.

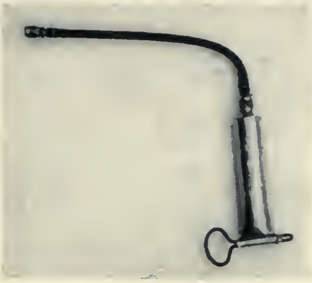
The last case concerns a man with ankylosis in the talocrural joint, consequent to a fractura tali et malleoli int. After the removal of the fragmina and the callus, vaseline was injected in the joint, which, by the by, was closed with suture without drainage. The wound healed per primam intentionem with good mobility.

There is no doubt that the injection of vaseline can be used like this with success to prevent ankylosis after joint resections on articulations not infected, which can be closed completely without drainage at the conclusion of the operation. Whether this method can be utilized in the resection of tubercular joints, elbow, shoulder, and foot joint, where it is of importance to preserve the mobility, is another question,—but I hope it will.

THE TECHNIC.

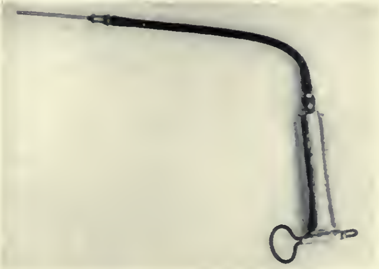
In conclusion, a few words about the technic of injection of vaseline in the joints.. In my first article I pointed out that this little operation, if not performed strictly correct, could

FIG. 1.



Vaseline tube with closed rubber drain for boiling.

FIG. 2.



The cover removed and the cannula screwed on the drain. Apparatus ready for injection.

perhaps involve danger to the patient in two ways: by *embolism* and by *infection.* A vaseline embolus can only occur if the cannula is caught in a blood-vessel and the injection happens into this. This accident can, however, be avoided by making the puncture with a blunt cannula with *poinçon.* Not until you have removed the *poinçon* and seen that no blood is running from the cannula, and that the latter is quite movable inside the articulation, can the injection take place. To secure an absolutely aseptic state of the vaseline I have the following manner of proceeding:

I have had a special apparatus made: (see Fig. 1) a tube of india rubber 10 cm. long, which at one end is provided with a brass ring which can be screwed on to the ordinary vaseline tubes, while the other end can be partly screwed into the cannula and partly into a close fitting cover, which fits the cannula and during the boiling can be closed with a little cover; provided with this cover the rubber tube is screwed on to the vaseline tube and is now boiled together with this for 15 minutes before the injection. Then the joint is punctured, the *poinçon* is removed, and the presence of synovia in the joint ascertained. In such a case catch the synovia in sterile glass tubes for examination. If it is found to be turbid and fluffy the injection of the vaseline is abandoned, but if none or only an inferior mass of clear synovia is found, the vaseline tube is taken direct from the cooking vessel and connected with the cannula by the connection tube, which after the cover has been removed can be screwed straight on to the cannula. The vaseline is now driven through the tube and cannula in this way: the vaseline tube is rolled up from the bottom by the aid of a tiny little handle (Fig. 2).

By this means every possibility of infection of the vaseline passing from the tube to the joint is precluded, and the method is in every respect practical. The whole thing would be even more simple if one dared use the edge-tool cannula, as then before the puncture this could be gathered with the rubber tube. But for several reasons I have rejected this manner of proceeding,—first because there is no assurance against emboli, and secondly because the operator is excluded from ascertaining whether there is synovia, and if so, what is its nature.

I puncture the *shoulder joint* by leading the trocar under the hindmost corner of the acromion; the *knee* by puncture outwards at the upper corner of patella. As regards the *hip joint* I have in most cases insured against missing the joint by exposing the joint capsule through an incision, 4 to 5 cm. long above the point of the trochanter. The capsule of the jaw joint I expose by the aid of a transverse incision under arcus zygomaticus. I consider this quite necessary, if one is to proceed safely and know what one is doing.

There is still one more very important question regarding technic, and that is what *quantity* of vaseline one is to inject in the different joints. Every guide was missing here, as I did not succeed in finding any examinations and reliable statements in cubic centimetres of the normal quantity of synovia in the different articulations of the body. I therefore had to experiment as I progressed.

The most roomy joint is the hip joint, which in adults takes 20 to 25 c.cm. of vaseline without any difficulty. While I had the luck here to find somewhat the right quantity, I greatly overestimated the capacity of the knee joint, as I suggested using 20 to 25 c.cm. here also, thinking that the knee joint would likely be able to hold more than the hip joint. That was a mistake which betrayed itself by the joint becoming distended and sore, so that in two cases I had to evacuate by a new puncture half the quantity of the vaseline injected, before obtaining a good result.

Ten to 12, at the very most 15 c.cm. is after my experience the suitable quantity for the knee joint. In exceptional cases, where one has removed parts of the end of the bones, as in Case XX, a larger quantity is of course wanted.

For the shoulder joint 15 c.cm. are considered suitable as a rule. The spot where the puncture has taken place is covered with collodion and absorbent cotton, and where no incision has taken place I let the patient begin to use the articulation at once.

THE LYMPHATICS OF THE COLON.

WITH SPECIAL REFERENCE TO THE OPERATIVE TREATMENT OF CANCER OF THE COLON.

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AND
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DURING the last four years we have been engaged on a research on the lymphatics of the alimentary canal, preparing for the purpose a large number of specimens injected by Gerota's method. Our material was drawn from subjects of all ages—chiefly children and young adults—as, except in the case of the appendix, fetal specimens are not very satisfactory. Previous work on the lymphatics of the colon had not shown the position of the primary glands and had done no more than furnish vague statements that the lymphatics ran with the blood-vessels. In April, 1907, our observations on the lymphatics of the cæcum and appendix were published,[1] and in March, 1909, we gave an account of the vessels and glands of the colon.[2] In these papers we indicated for each part of the large intestine the extent of the operation which the anatomical facts demanded. Recent papers on the subject appear either to ignore the necessity of complete removal of lymphatic areas or to recommend operations based on a faulty conception of the anatomy of the lymphatics. The methods of operation for cancer of the colon outlined in the following pages have been practised without any special difficulty and without mortality.

The Necessity for Removing Lymphatic Glands in Cases of Cancer of the Colon.—No operation for malignant disease can be considered complete without the removal of lymphatic glands. In the colon, as elsewhere, cancer gives rise to secondary gland disease, though it is accepted that this gland invasion may be late or even absent (Treves,[3] de Bovis[4]). In many cases it is overshadowed by secondary visceral disease. The glands may be enlarged from inflammatory disease without malignant infiltration (Bilton Pollard[5]). H. S. Clogg found cancerous deposits in the lymphatic glands in 28 out of 45 cases of malignant disease of the cæcum and colon.[6] Recurrences are known to be frequent after colectomy (de Bovis, Clogg); some no doubt are due to visceral disease unmasked at the time of operation: other recurrences are indubitably glandular. It is impossible for the surgeon to determine at the time of operation whether a growth in the colon has given rise to secondary gland infection or not. To minimize as far as possible the likelihood of recurrence, it is necessary to remove with the primary growth those glands which are likely to have become affected. The primary glands—those receiving direct vessels from the gut—will be the first to become diseased by cancerous emboli carried to them along the lymphatic vessels from the primary growth, and any one primary gland is just as likely to become affected as another, whatever may be their comparative position with regard to the colon. In those portions of the colon supplied by long arterial arcades the paracolic glands at some little distance from the seat of the disease may become affected; this applies in particular to the transverse colon and to a lesser extent to the ascending and descending colon. The lymphatic vessels which emerge opposite the centre of the arcade have to travel in one direction or the other for a considerable distance parallel to the gut before they reach an arterial trunk along which they can pass towards the main groups. These vessels enter some paracolic gland on their way, while a vessel issuing opposite the trunk of one of the larger colic arteries would, after the same length of course, have reached an intermediate or even a main group gland. It is evidently necessary to remove the paracolic glands for some little distance on each side of the primary growth, and this necessitates excision of a considerable length of gut; in particular this applies to the transverse colon.

The ideal operation consists in removing a considerable length of gut on each side of the growth, the primary glands, together with the vessels running to them from the gut, and the tissues in which these vessels lie—*i.e.,* the so-called "lymphatic area."

In some situations it is impossible to remove the whole of the lymphatic area—*e.g.,* at the splenic flexure. In removing the primary glands many of the secondary glands will be included, but the secondary glandular system of any part of the colon is too extensive to permit excision. In certain cases it may be found that although the local conditions are favorable for excision, glandular hypertrophy has extended beyond the primary glands and has involved the secondary glands. If the secondary glands are certainly malignant it would appear to be useless to proceed with the operation, except as a palliative measure. The difficulty of determining malignancy in any given enlarged gland must, however, be borne in mind, and where there is the least doubt the growth with the primary glands should be excised in the hope that the enlargement of the remaining glands may be due to absorption from the ulcerated surface in the bowel, and not to malignant infiltration. That is to say, in every case in which the local and general conditions are favorable, the growth with the corresponding lymphatic area, or as much of it as is possible, should be excised apart altogether from the presence or absence of enlargement of lymphatic glands.

The Lymphatics of the Large Intestine.—The lymphatic glands of the large intestine (Fig. 1) are scattered along the course of the blood-vessels and may be described in chains corresponding to these vessels, viz.: the ileocolic chain, the middle colic chain, the left colic chain, and the inferior mesenteric chain. In each chain, at certain points the glands tend to form groups which owing to the presence of scattered glands between them, are not sharply defined from each other; it is convenient for purposes of reference to name them, epicolic, paracolic, intermediate, and main groups.

The *epicolic glands* lie on the intestinal wall, often in the bases of the appendices epiploïcæ, and are most numerous on the sigmoid flexure. They are small and unimportant and will not be mentioned in the description of the various chains.

The *paracolic glands* lie along the gut on the vascular arcades and the short straight terminal vessels proceeding from the arcades.

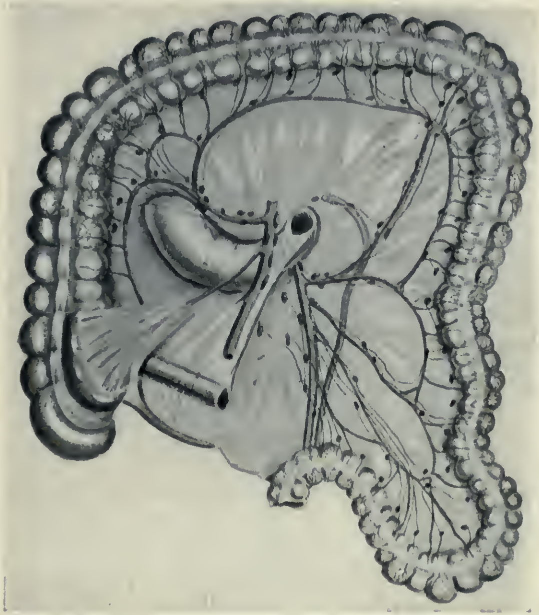
The *intermediate glands* are situated about midway between the arcades and the origins of the colic and sigmoid vessels.

The *main group glands* surround the stems of the vessels near their origin.

The ileocolic chain (Fig. 2) drains the lower end of the ileum, the cæcum and appendix, and the greater part of the ascending colon. Its paracolic glands lie along the inner side of the ascending colon (right juxtacolic glands), in the ileocolic fold (anterior ileocolic glands), and behind the ileocolic junction (posterior ileocolic glands). The intermediate glands lie on and above the point of division of the ileocolic artery into its various branches. The main group lies on the upper part of the artery and therefore partly in front of the duodenum. The scanty chain of glands lying on the right colic artery joins the main group of the ileocolic chain. The vessels from the ascending colon, cæcum and appendix, and terminal part of the ileum are not all intercepted by the paracolic glands; many proceed to the intermediate glands and a considerable number to the main group. Meso-appendicular glands are merely prolapsed members of the paracolic or intermediate groups, and their presence or absence is of no importance. There is no communication between the ovarian lymphatics and a meso-appendicular gland.

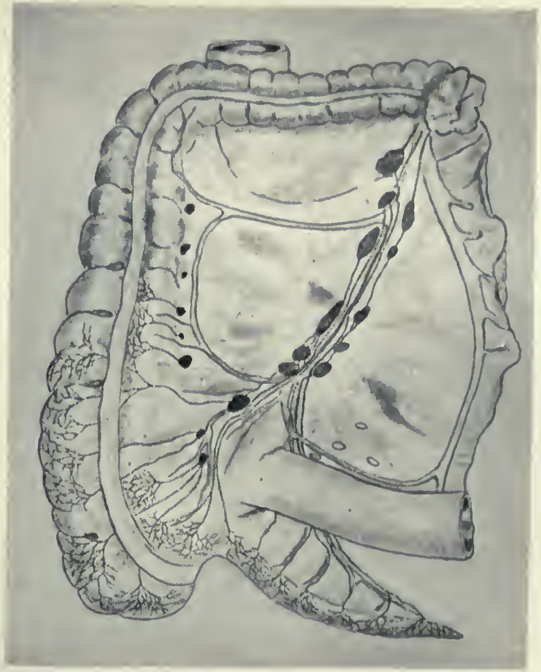
THE OPERATION FOR MALIGNANT DISEASE OF THE CÆCUM, AND LOWER PART OF THE ASCENDING COLON (Fig. 3).—In cases for radical treatment the operation necessitated

FIG. 1.



The lymphatics of the colon. (Proc. Roy. Soc. of Medicine.)

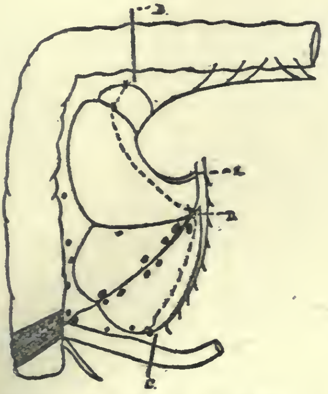
FIG. 2.



Lymphatics of the cæcum and appendix. Anterior view. (Lancet, Apr. 27, 1907.)

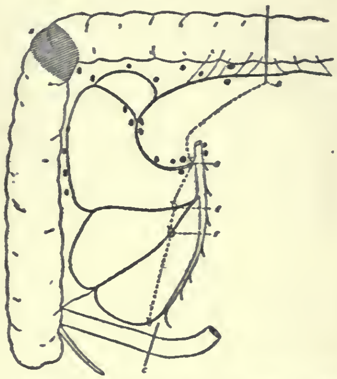
by the arrangement of the lymphatics is, viz.: After exposing the field of operation the lower border of the third part of the duodenum is defined. The peritoneum over this is divided and the ileocolic vessels are found. The fatty tissue surrounding the vessels which will contain the uppermost gland of the ileocolic chain is stripped downwards with gauze, care being taken not to wound the duodenum. The artery and vein are ligatured and divided close to the superior mesenteric artery. It is well at this stage to select the point on the transverse colon where the gut shall be divided. The transverse mesocolon is then divided up to the selected point, some branches of the middle colic artery being secured. The middle colic artery itself is carefully preserved. If the right colic artery has a separate origin from the superior mesenteric it will need ligature. The peritoneum of the mesentery is then divided in an oblique line downwards to the ileum. The ileocolic and right colic vessels, with the accompanying chain of glands, the fatty tissue and the overlying peritoneum, are then stripped downwards to the ileum and cæcum and outwards to the colon. The ureter and spermatic vessels are encountered and

FIG. 3.



Excision of growth in the cæcum. *A*, growth; *B*, line of section of transverse colon; *C*, line of section of ileum; *D*, point of ligature of ileocolic artery; *E*, middle colic artery.

FIG. 4.



Excision of growth at the hepatic flexure. *A*, growth; *B*, line of section of transverse colon; *C*, line of section of ileum; *D* point of ligature of middle colic artery; *E*, point of ligature of right colic artery· *F*, point of ligature of ileocolic artery.

must be avoided. The cæcum is then lifted up and the peritoneal reflection to the outer side of the colon is divided. The cæcum and appendix, the whole of the ascending colon, and the terminal portion of the ileum, with the ileocolic and right colic vessels and the lymphatic chain, can then be withdrawn from the abdomen, only remaining attached by the continuity of the intestine. The colon is divided at the previously selected point and the ileum about six inches from the valve. The operation is terminated by an ileocolostomy to the transverse colon, or—as was necessary in one of our cases—to the sigmoid colon.

The *Middle Colic Chain* drains the area of distribution of the middle colic artery—the upper part of the ascending colon, the hepatic flexure and about two-thirds of the transverse colon. The paracolic glands are disposed in the manner already mentioned; the intermediate group lies on the artery just above its bifurcation about midway between the bowel and the root of the mesocolon: the main group is placed on the stem of the artery at the root of the mesocolon in front of the head of the pancreas, sometimes blending with the superior mesenteric glands. Direct vessels reach the intermediate group in all cases and the main group in many, but only from the hepatic flexure, the upper part of the ascending colon and the right end of the transverse colon. The vessels from the central portion of the transverse colon are all intercepted by the paracolic glands.

Operation for Growths in the Neighborhood of the Hepatic Flexure (Fig. 4).—Growths in this situation are not uncommon but are rarely removable as they quickly become adherent and fixed to neighboring structures—pancreas, duodenum, etc. To remove the " lymphatic area " it is necessary to tie the middle colic artery at its origin from the superior mesenteric and to remove the mesocolon from this point up to the bowel. By this step the whole of the middle colic chain of glands is secured. Ligature of the artery devitalizes so much of the ascending colon—particularly in those cases where the right colic artery has origin from the middle colic—that it is necessary to remove the whole of the ascending colon, with the cæcum and terminal six inches of the ileum, the growth at the hepatic flexure and about half the transverse colon, completing the operation by a lateral anastomosis between the ileum and the transverse colon.

The Left Colic Chain.—The paracolic glands lie in the usual situation. The intermediate group is scattered, but the majority of the glands lie on the artery just above the point where it is crossed by the inferior mesenteric vein, in front of the inner border of the kidney. The main group is divided: one part lies on the left colic trunk close to its origin, the other part on the curved upper end of the inferior mesenteric vein, and is continuous with the glands about the head of the pancreas (superior mesenteric and lumbar). Direct vessels from the splenic flexure reached the intermediate group in 4 out of 14 of our specimens, and from the descending colon in 5 out of 15. We have never seen a direct vessel passing to either part of the main group.

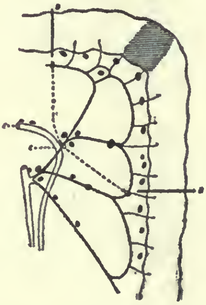
From the greater part of the transverse colon the vessels enter the paracolic glands; they run parallel to the gut along the arterial arcade in either direction, and are invariably intercepted after a longer or shorter course by these glands. We have never seen them enter even the intermediate groups of the middle or left colic chains. It is only as we approach the flexures that we find vessels passing by the paracolic glands.

In the left half or two-thirds of the transverse colon there is an additional outlet for the lymph. In well-injected specimens we find that vessels arise from the anterior surface of the colon, run into the gastrocolic omentum, and then turn to the left between the ascending layers of this fold to reach, finally, the glands at the hilum of the spleen. The vessels from the middle of the transverse colon are necessarily very long, and there may be small interrupting nodules on them. We have also noted in two cases vessels ascending from the back of the upper end of the descending colon (lower limb of the splenic flexure) to the splenic glands.

Operation for Growths in the Middle Portion of the Transverse Colon.—We have noted above that the lymphatics of this segment are all intercepted by the paracolic glands. The removal of a length of bowel (3 to 4 inches), on either side of the growth with the corresponding portion of the mesocolon containing these glands, will suffice. It should be possible in all cases to preserve so much of the transverse colon as will permit an end-to-end anastomosis.

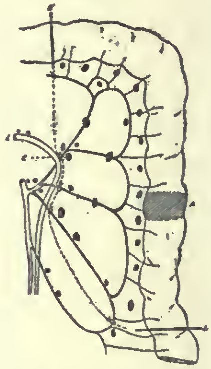
Operation for Growths in the Region of the Splenic Flexure (Fig. 5).—The left colic artery is defined as it leaves the inferior mesenteric vein, and is tied at this point with the accompanying vein. The bowel is then freed by incising the peritoneum to the outer side of the descending colon and splenic flexure and separating the bowel with the growth, the peritoneum and the subperitoneal tissues containing the lymphatic glands and vessels from the posterior abdominal wall. The mesocolon is then divided from the point of ligature of the artery, upwards to a selected point on the transverse colon. The selection of this point will be determined by the extent of the transverse colon supplied by the middle colic artery; it will lie as a rule at the junction of

Fig. 5.



Excision of growth in the splenic flexure. *A*, growth; *B*, line of section of transverse colon; *C*, point of ligature of left colic artery; *D*, line of section of descending colon; *E*, inferior mesenteric vein.

Fig. 6.



Excision of a growth in the descending colon. *A*, growth; *B*, line of section of transverse colon; *C*, point of ligature of left colic artery; *D*, line of section of sigmoid flexure; *E*, inferior mesenteric vein.

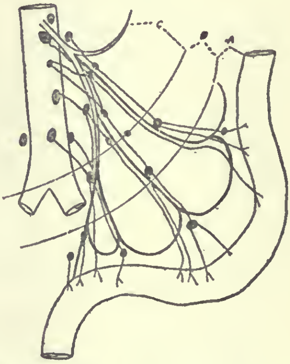
the middle and left thirds of the transverse colon. The peritoneum is also divided in a direction downwards and outwards to the descending colon. At the selected point on the transverse colon the bowel is divided; below, the descending colon is divided in its lower part and the operation is completed by an end-to-end anastomosis.

OPERATION FOR GROWTHS IN THE DESCENDING COLON (Fig. 6).—The "lymphatic area" corresponding to this part of the colon comprises the epicolic and paracolic glands and the intermediate glands on the branches of the left colic artery, including those on the uppermost sigmoid artery. Some vessels also run to the splenic glands, as in the case of the splenic flexure. It will then be necessary to tie the left colic artery at the point where it leaves the inferior mesenteric vein, and also the uppermost sigmoid artery close to its origin. A reference to the diagram will show that beyond this step the operation is much the same as that for the splenic flexure except that, below, the gut will be divided in the upper part of the sigmoid flexure.

The Inferior Mesenteric Chain.—This chain of glands drains the sigmoid flexure and rectum. The paracolic glands lie in the position described above. The intermediate glands lie on the sigmoid arteries—those on the highest sigmoid branch being found between the lower end of the kidney and the iliac crest, those on the other branches in the root of the mesosigmoid. The main group surrounds the inferior mesenteric stem below the origin of the left colic chain, both chains becoming continuous with the lumbar glands at this point. Direct vessels reach the intermediate glands in all cases. The lower end of the main group necessarily lies near the intestine at the pelvic brim and is comparable to the paracolic group in other parts, receiving therefore numerous direct vessels. The middle portion of the chain is in series with the intermediate glands on the sigmoid arteries and receives direct vessels, but the upper part of the chain never receives vessels directly from the gut, resembling in this respect the main group of the left colic chain. From all parts of the group vessels pass to the lumbar glands (Fig. 7).

THE OPERATION FOR GROWTH IN THE LOWER PART OF THE SIGMOID FLEXURE AND THE FIRST PART OF THE RECTUM (Fig. 8).—This may conveniently be considered before we discuss the operation for a growth in the middle of the sigmoid flexure. The glands requiring removal are those lying around the inferior mesenteric artery and its continuation, the superior hæmorrhoidal artery, from the point of origin of the left colic artery downwards,—this includes all the primary lymphatic glands. It is not necessary to remove the glands around the stem of the inferior mesenteric artery above the point of origin of the left colic artery; these glands are not primary glands and are indeed less likely to become diseased from a growth in the situation we are now considering than are the lower glands of the lumbar group. Further, if these glands are secured by ligaturing the inferior mesenteric stem close to its origin from the aorta, the blood supply of the upper segment of bowel will then depend entirely on the anastomosis between the left colic and middle colic arteries, which may be insufficient.

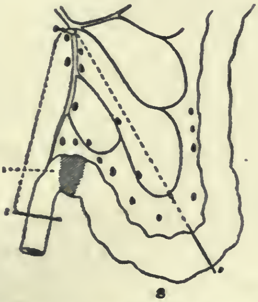
FIG. 7.



Showing how the lowest and middle glands of the inferior mesenteric chain are homologous with the paracolic and intermediate groups on the sigmoid arteries. *A*, paracolic group; *B*, intermediate group; *C*, main group.

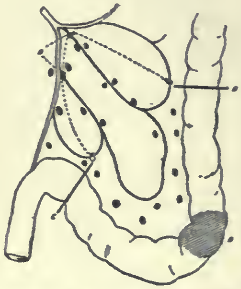
The operation consists in exposing the inferior mesenteric artery and ligaturing it and the vein just below the point of origin of the left colic artery. A long incision through the peritoneum is made on the outer side of the mesorectum, mesosigmoid, and descending colon, and the gut mobilized by stripping it inwards towards the middle line. In doing this the ureter and spermatic vessels are encountered and must be avoided. The mesosigmoid is then divided in an oblique line downwards from the point of ligature of the inferior mesenteric to about the middle of the sigmoid flexure, care been taken to preserve as far as possible the secondary arches on the sigmoid arteries. The peritoneum to the inner side of the artery is then divided downwards to the inner side of the mesorectum. The mass of tissue to be removed is then stripped forwards from the sacral hollow and the middle sacral artery is secured. The peritoneal reflection from the bladder to the rectum is divided.

FIG. 8.



Excision of a growth at the junction of the sigmoid flexure and the rectum. *A*, growth; *B*, line of section through the sigmoid flexure; *C*, line of section through the rectum; *D*, point of ligature of the inferior mesenteric artery.

FIG. 9.



Excision of a growth in the middle of the sigmoid fixture. *A*, growth; *B*, line of section above the growth; *C*, line of section below the growth; *D*, the sigmoid arteries tied at their origin. (Proc. Roy. Soc. of Me .)

The operation may be terminated in one of three ways. (*a*) By cutting across the rectum below and the sigmoid flexure above, closing the rectum by sutures and effecting a permanent colostomy,—an undesirable method but one which will be necessitated in a certain, perhaps considerable, proportion of cases. (*b*) By dividing the rectum and sigmoid colon as above and effecting an anastomosis from within the abdomen. The vitality of the lower segment depends on the middle and inferior hæmorrhoidal arteries and branches of the sacral arteries. We have not yet enough evidence that these are sufficient in all cases to permit the retention of a length of the rectum necessary for the performance of an anastomosis. (*c*) By making a perineal incision, pulling the whole mass of tissue through the outlet of the pelvis and anastomosing the middle of the sigmoid flexure to the anal stump (Maunsell, Tuttle, etc.).

Of these three methods the third appears to be the best. There will be many cases, however, where owing to the poor condition of the patient, to excessive stoutness, to distention of the bowel, etc., it will be impossible. In such cases a colostomy is indicated. In cases where an iliac colostomy has been done previously on account of obstruction, although it may be possible to close the opening and effect an anastomosis after resection of the growth, it will probably be wisdom to preserve the colostomy permanently.

OPERATION FOR GROWTHS IN THE MIDDLE AND UPPER PART OF THE SIGMOID FLEXURE (Fig. 9).—The lymphatic glands receiving direct vessels from this part of the colon include the epicolic and paracolic glands, the intermediate glands lying on the sigmoid arteries in the mesosigmoid, and the main group glands on the inferior mesenteric artery. The "ideal" operation in these cases is practically the same as that described above, with the difference that more of the mesosigmoid will be removed and the gut will be divided above at the junction of the descending colon and the sigmoid flexure. This "ideal" operation will be terminated in a certain proportion of cases by a permanent colostomy, and it must be remembered that the purely local excision of growths in this situation, with preservation of the alimentary circulation, has been attended with a considerable measure of permanent success. If the "ideal" operation necessitates a colostomy the comparative disadvantage is so enormous that it will rarely be performed. Being unwilling to consider even the possibility of a permanent colostomy after excision of a growth in the middle of the sigmoid flexure, we must perform an operation which if short of the ideal does remove the majority of the possibly affected glands.

The operation consists in exposing the inferior mesenteric vessels, dividing the peritoneum over them and stripping off as many of the glands of the main group as is possible without damaging the vessels. This is done from the point of origin of the left colic artery down to the origin of the lowest sigmoid artery. The sigmoid arteries are tied at their origin, the lowest being preserved if its ligature be not necessitated by the position of the growth. The descending colon is then mobilized and the gut divided above at the junction of the descending colon and the flexure, and below in the lower part of the flexure. Almost the whole of the mesosigmoid will thus be removed, including the intermediate, paracolic, and epicolic glands and probably the greater number of the main group glands corresponding to this part of the sigmoid flexure. The operation is terminated by an end-to-end anastomosis between the end of the descending colon and the lowest part of the sigmoid flexure. If it is found necessary to tie the lowest sigmoid artery at its origin care must be taken to divide the gut well below the level of the brim of the pelvis, in order to avoid the " dead end " which may be left, as Manasse and Archibald have shown, owing to the non-union of the branches of the lowest sigmoid and superior hæmorrhoidal arteries.

In a recent paper, Dr. W. J. Mayo[7] gives diagrams of suggested operations for cancer of the colon, designed to remove the associated lymph-glands. He does not give any reference to the writings or specimens on which his anatomical descriptions are based, and the accuracy of these is open to criticism in many respects. We may note that the tendency of the lymph drainage of the descending colon is not towards the transverse mesocolon, following the middle colic tributaries, as Dr. Mayo states; the lymphatic vessels run with the left colic artery. The lymph drainage of the splenic flexure and adjacent transverse colon is in the opposite direction to that of the hepatic flexure and the greater part of the transverse colon. Their direction would only be the same if the middle colic artery supplied the whole of the transverse colon, including the hepatic and splenic flexures, which is not the case.

In Dr. Mayo's diagrams (Figs. 7 and 8 in his paper[7]) showing the lines of the proposed resection of the sigmoid, it will be noted that a considerable loop of sigmoid colon is shown to be left, below the portion which is resected. As the inferior mesenteric artery has been tied the blood supply of this loop depends entirely on the middle and inferior hæmorrhoidal arteries and on twigs from the sacral arteries; it is questionable whether this will suffice for such a length of bowel as is depicted.

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SOME CONSIDERATIONS UPON HIGH AMPUTATION OF THE RECTUM.

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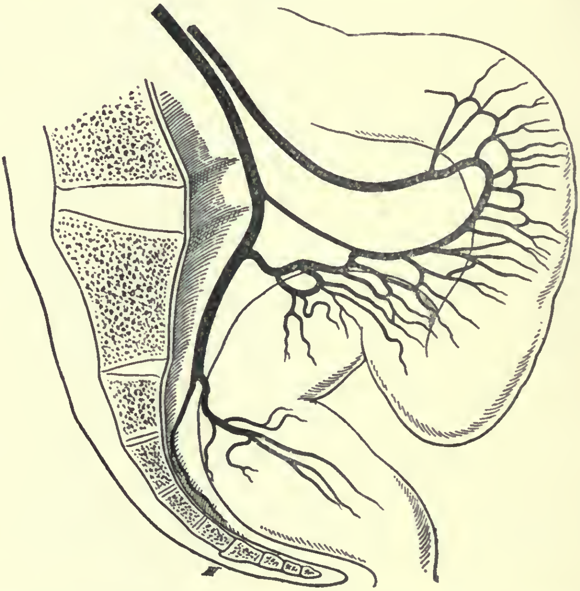
After high perineal amputations of the rectum we have twice seen gangrene of the terminal portion of the intestine that had been brought down, and in several cases after perfect operative recovery we have observed recurrence in the connective tissue of the pelvis even when the mucous membrane remained intact. In these two series of cases in which there was either primary gangrene of the rectum or secondary recurrence in the connective tissue, we had to do with patients in whom we had been obliged to cut the hemorrhoidal arteries quite high up, either because the cancers were located high in the ampulla, or the cancer—though seated lower down upon the mucosa—was accompanied by an infiltration of the mesorectum by the neoplastic extension. It is not rare to see in such cases, once the prerectal peritoneal cul-de-sac has been opened, the rectosigmoid portion present itself and permit itself to be easily drawn down, while the rectum proper, especially its ampullary portion, remains fixed, being held firmly by the superior hemorrhoidal branches which descend in a straight line from the aorta. In order to make possible the coming down of this portion of the intestine, it is absolutely necessary to cut the superior hemorrhoidal vessels. It is then easy to draw the rectum outside; but, as far as can be seen, there develops a consecutive gangrene, the pathogeny of which is explained by the anatomy of the vascular system of the region, the arterial circulation of the rectum being very different from that which is present in other portions of the intestine. While in the latter there are present a series of anastomotic loops, upon the rectum one sees the hemorrhoidal arteries descend without forming the slightest anastomotic loop.

This has been well shown by the researches pursued at my suggestion by de Dietrichs, in my laboratory. The injections which he has made indicate: First, that the ligature of the inferior mesenteric artery does not affect the circulation of the rectum, provided it be done between its origin and the giving off of its last important collateral branch which arises from 1 cm. to 1½ cm. below the promontory (see Fig. 1).

Fig. 1.



Arterial circulation of the rectum.—Note the difference in the arrangement between the arteries of the pelvic colon, which form an anastomotic loop, and the superior hemorrhoidal arteries, which present no important anastomosis. Note the constant situation of the last anastomotic loop, a little below and to the left of the promontory.

Second, that the ligature of the terminal portion of the inferior mesenteric below this last collateral branch produces almost complete suppression (or even complete) of the arterial supply of the rectum and of the rectosigmoid junction. The suppression is so much the more complete since in the course of the perineal amputation one separates the lower part of the intestine from its peripheral connections, and since one cuts consequently the branches of the middle hemorrhoidal artery,—an accident less important indeed than the descriptions in recent treatises on anatomy would lead us to suppose. Third, that ligature of the trunks of the superior hemorrhoidal artery, right and left, produces suppression of the circulation in corresponding sides of the rectum. In a way, the superior hemorrhoidal arteries answer to the type of terminal arteries.

The results of these researches, in great part confirmative of those published two years ago by Sudeck (*Muench. med. Woch.*, 1907, pp. 13, 14), are that if the operator wishes to have an intestine which may be brought down to the level of the skin of the perineum without traction and still well nourished, it is necessary to avoid cutting the hemorrhoidal arteries at the point where one is led necessarily to divide them when working exclusively from the perineum. It is necessary to place a ligature high up on the common trunk of these arteries above the last anastomotic loop which, as we have said, is found a little lower than the promontory, and it is necessary to tie both ends, the blood flowing back in abundance by the inferior end. In consequence of not having done this last ligature we have lost a patient from hemorrhage.

The necessity of making this high ligature of the hemorrhoidal pedicle, obliges one to begin the operation through the abdomen, whereby the advantage is gained of being able to divide immediately, along the sides of the rectum, the peritoneum and the subjacent fibrous tissue which with the hemorrhoidal pedicle forms the chief source of fixation of the upper part of the rectum. The same path will be utilized also to strip up from in front whatever infected connective tissue surrounds the rectum, blood-vessels, lymphatics, and glands. At the same time while the operator will be protected from the danger of secondary gangrene, he will have accomplished an extirpation much more extensive than by the ordinary procedures through parts which may be invaded by the cancer. This done, he will have only to finish the operation by isolating through the perineum the lower part of the rectum, as one does for low amputations of this segment of the intestine, and to bring it down until the outside portions shall be manifestly healthy. This is possible in a great majority of cases without the least traction, in consequence of the straightening out of the sigmoid flexure. However, when the meso of this loop is short, the intestine may be seen to descend vertically into the pelvis, like a clock pendulum, isolated on all sides, which is a bad condition for ultimate cure. The intestine ought, at the end of the operation, to be in contact with the neighboring parts, resting directly on the sacral concavity and following its curvature in such a manner that it may readily and quickly become adherent to the neighboring parts. To accomplish this in cases of shortness of the mesosigmoid, it is necessary to incise the peritoneum alongside the colon in such a way as to mobilize downward and toward the median line the intestine with its vascular meso preserved intact. One may also cut the intestine across, fix its upper end in an iliac incision and extirpate the lower end in totality.

By following the technic that we have just indicated, the operator is able to prevent gangrene of the end of the intestine and will make a much wider removal of the cancerous growth along the lymphatic paths, realizing what one might call by analogy with the operations recently done for uterine cancer, wide ablation of cancer of the rectum.

It is true that up till now the results of abdominal and perineal amputations of the terminal parts of the intestine have not been very encouraging. We believe, however, that with the actual improvement of the technic they will become better, and that the abdominoperineal path is to be the path of the future. Personally, we have in these recent days done this abdominoperineal operation four times,—three times bringing down the pelvic colon through the perineum and once the upper end in an iliac incision and total extirpation of the lower end. We have had three cures and one death by hemorrhage (case mentioned above), the result of an operative fault which it should be possible to avoid.

PRINCIPLES OF A RADICAL TREATMENT FOR PROCTOSIGMOIDITIS.

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In recent years I have met with a relatively large number of cases commonly called strictures of the rectum, but which really involved greater problems than those connected with a simple stricture. Treatment of these cases is not in great favor among surgeons owing to the difficulties and failure of routine methods, and for that reason I wish to submit to the profession some principles and observations relating to this kind of case.

The ætiology and pathogenesis of the rectal stricture has been much discussed. Especially after Virchow's description, they have been called, without discrimination, syphilitic. Virchow truly said that the syphilitic nature of these strictures was admitted by him for analogy with the chronic ulcerations and narrowing scars produced by syphilis in the larynx; but he could not say (having never seen it) how it begins—whether with gummata or with condylomata; and in many cases he would be embarrassed to decide between syphilitic, diphtheritic, and dysenteric ulcerations,—only he knew that the first had a lower situation and were more regular and flat. Clinically, too, for a while it was assumed that these lesions were syphilitic, because of their greatest frequence in syphilitic persons and in prostitutes; but later it was found that in some instances lues was surely to be excluded, in many others no anatomical proof could be given of their luetic nature, and in none specific treatment was ever of any benefit.

Next it was discovered that some cases are tubercular, some consecutive to morbid processes outside of and near the rectum,—and for others blennorrhagia was held responsible. But in many instances the true explanation was lacking, and for these was admitted the existence of a proctitis of no definite nature arising from many possible common causes,—and this idea was so extended by some as almost to exclude syphilis from the great majority of cases. Among my observations I find that abnormal sexual intercourse had in almost every instance taken place either occasionally or habitually, so that it could easily be assumed that this was the most common way of the infection, whatever it may be. But it was impossible to find any bacteriological or anatomical proofs to support the view that the blennorrhagic infection was the primary one, notwithstanding my feeling and tendency to give to it a great part. Tubercular origin was never found among my cases, and I believe that the presence of giant cells with leucocyte accumulation, even in form of so-called follicles, has no decisive importance in defining the nature. Once the stricture was consecutive to dysentery. In the major number of cases the anatomical findings were greatly in support of syphilitic origin, but how they can be demonstrated I will leave for another occasion—being a too long discussion and too far from the principles of therapy, which I will resume.

No treatment can be claimed to be the sole one for these cases. The sound principle to guide one, is that the anatomic conditions of each instance only can bring us to a rational therapy. Prominent among the anatomic conditions is not to be considered the stricture itself but the inflammation of the rectum and its extent, since the stricture is a limited consequence only, not the essential disease; so that if we succeed only in removing the strictured part we have done nothing at all in the majority of cases, the inflammation being still there with all its actual symptoms and promise of a new stricture in the future. Consequently, the first question is to know how high the disease is extending in the rectum and possibly in the colon sigmoideum or even in other sections of the bowel. It is only in a few instances that this question is of little importance,—that is when we have to deal with strictures in the form of a ring or diaphragm secondary to a limited circular ulceration while the mucosa above it is practically healthy and not infiltrated. But generally the condition is that of a more or less high-located and extensive tubular stricture with ulcerated mucosa above it and infiltration of all the walls of the gut and of the periproctal structures even where the mucous membrane appears healthy, and to such an extent in some cases as to reach the upper portion of the rectum, the sigmoid colon and the higher portion of the bowel. The infiltrated gut is thick and shortened, the ring-like lumen very much reduced, the surrounding fat fibrous, the mobility greatly diminished. In one case, even in the small intestine, near the cæcum, was an extensive infiltration and narrowing. We have to do in these instances not only with the stricture but with a proctitis, sigmoiditis, etc., so that the excision of the stricture cannot bring a permanent benefit. It is evident that applying a routine treatment to such a manifold variety of lesion cannot bring a good result. A ring-like stricture can be efficiently cut and dilated, a short tubular narrowing with limited infiltration can be kept open by a patient prolonged dilatation, but in many other cases these means are useless, even very dangerous. The possibility of checking the inflammation by means of an artificial anus, irrigating the diseased part through it, passing bougies, elastic tubes, etc., is to be admitted only exceptionally effective. In my experience the artificial anus has been followed by a steadily progressive narrowing of the inflamed gut which after a long period of disuse may become converted into a hard unyielding scar. I have completely abandoned all these procedures as a rule, and I have resorted, like many others, to the only radical treatment, an excision based on the principle of an exact knowledge of the extension of the disease. Because of the lack of such preliminary information we see that although excision has been for a long time frequently resorted to, the results have not been very satisfactory. If it were possible to group the reported operated cases according to the extent of the lesion, I believe we could easily find that in all in which a proctitis or proctosigmoiditis was existing the result was nil. Recurrence of the stricture, permanence of the discharge and of distressing symptoms is the usual consequence of such operations notwithstanding they appeared very extensive and liberal at the moment. Certainly some recurrence may be due also to the technic employed, failure of suture, etc., but chiefly to the above discussed reasons.

I hope that for the efficiency of surgical treatment, surgeons will agree with me on this first principle, that is, the necessity of an exact preliminary knowledge of the extent of the disease. Clinically this is seldom possible. Symptoms and physical examination can sometimes make out this point, sometimes can induce a suspicion, almost never can exclude a high inflammatory involvement. Consequently follows the necessity of an exploratory laparotomy for examination of the intestine as a preliminary to the radical treatment. This may at first seem a too severe method of diagnosis; but if we consider its importance on one side, and if on the other side we agree on the absolute necessity of starting the treatment by the establishment of an artificial anus, my proposition will be accepted as a legitimate one.

The reasons for an artificial anus are obvious. The patients come to us in a very poor condition, emaciated, even cachectic, running sometimes a continuous fever or having intermittent attacks of it, with pain and distress at short intervals in accomplishing the imperfect bowel function. They need a long period of rest to be fit for a severe operation. Besides, the artificial anus is our best safety-valve, allowing aseptic operating and a clean after-treatment.

Where to establish the anus and the way of exploration will be briefly discussed. In some instances I have done it on the right, in others on the left side, always through a gridiron incision. This can be made, if needed, as large as is required for a clear examination of the abdomen, by cutting transversely the anterior rectus muscle sheath and pushing the muscle medially. If it has been made on the right side, so that a cæcostomy has to follow, the incision should be larger, it being more difficult to reach the colon sigmoideum and the rest of the colon. Palpation and inspection, drawing possibly the more movable parts into the wound, have to be used, and not to be forgotten is the examination of the last loop of ileum where stricture can be present without having given peculiar symptoms. The cæcostomy has to be very large to assure a complete drainage of the colon, and for this purpose I draw into the wound the cæcum and the ascending colon. Often the small intestine invaginates later through the ileocæcal valve and protrudes from the cæcal wound, but this has no bad consequence and gives us the most effective and sure total drainage. On the left side the exploration of the sigmoid is easier, and has the advantage that in case of high infiltration of the cæcum and of colon we can cut the intestine near the upper limit of disease, suture and drop the distal portion, fixing the proximal to the skin, insuring the best function of the anus. The distal segment is ready for the future perineo-abdominal extirpation, the proximal for its mobilization and transplantation into the anus.

But if we do not find high involvement of the rectum, so that no abdominal operation is needed, then the left artificial anus has clearly the disadvantage of having established adhesions of the sigmoid and of having created an opening in a portion of gut which it may be has to be lowered down into the pelvis. For this reason I usually explore from the right side, establishing a cæcal colic large anus. The patient is treated for weeks and months with saline washing from the artificial anus and from the rectum with a thin soft tube, till the general conditions are good and the fever has disappeared.

The radical operation will now follow, and it will be guided by what the preliminary exploration has ascertained. If the lesion is a limited one we may perform a perineal extirpation; if extensive, we have to resort to a combined operation, in both cases the aim being to preserve the function of the sphincter and to put into it a healthy portion of bowel. For preserving the function the common practice in rectal surgery has been a resection of the bowel, leaving the anus intact and suturing the two ends together, or to insert the proximal end through the anus after dissection of its mucosa, to the skin. I have abandoned these principles. Usually the anal portion, in our cases, is much deformed, the mucosa is infiltrated, rigid, adherent to the other layers; a circular suture is difficult and easily fails or has the tendency to contract later. The insertion of the proximal end through the anus is frequently difficult if the rectum has been removed low down in the limits of the ampulla, the size of this not corresponding exactly to that of the deformed anal portion,—and if the rectum has been removed high so that the sigmoid has to be pulled down after mobilization, there is no good room for the adaptation of the thick mesentery into the anal ring. In both cases a failure of the suture can happen with a certain consequent stricture. Besides, I have found that it was technically much more difficult for me to resect the rectum leaving intact the anal portion, as it is sometimes extremely difficult (in contrast with cases of cancer) to isolate the adjacent strictured rectum in its whole and then cut it and resect from below upward or vice versa, without disobeying the rules of asepsis.

I consider as the safest and easiest way that proposed by Witzel in 1906 for an aseptic removal of cancer of the rectum. The Kraske method or one of its modifications are not necessary at all; the vaginal route has the disadvantage of a possible very troublesome vaginorectal fistula.

I will sketch briefly the Witzel operation, being rarely adopted as far as my observation goes. The principle is to preserve the function of the sphincter and to perform an aseptic operation throughout till after closure of the external wound. I put the patient under novocain spinal analgesia, in an exaggerated lithotomy position, with the upper part of the body in Trendelenburg medium inclination, so as to have the abdomen ready to be opened in case of need. The sphincter is relaxed by the novocain so amply that the mucosa is easily accessible and can be exactly closed with one or two rows of fine stitches, not including the skin. Gloves are changed, the region is disinfected again, and an incision is made in the median line posteriorly, from the anus to the middle of the sacrum, laying bare and excising the coccyx first, then going deeper, reaching the rectum posteriorly and dissecting it bluntly from the concavity of the sacrum to the promontory, and on the sides. In the upper part—that is, near the anus—the incision goes to the external sphincteric ring and divides it exactly in the median posterior line, avoiding carefully injury to the previously closed mucosa ani. As the extremities of the cut sphincter retract spontaneously, they allow a clear dissection of the mucosa ani from the muscular fibres all around and high up, till we reach and open on the sides the funnel-shaped fat space limited laterally by the levator ani, covered by the pelvic aponeurosis, and mesially by the rectal wall. In this space proceeds the blunt dissection laterally of the closed rectal tube, and as the cut and dissected sphincter in a horseshoe form can with its lateral nerve supply intact be widely retracted by instruments, we have ample room for an exact dissection of the vagina or of the prostate from the rectum, for reaching and cutting the Douglas pouch (in every case!), for dividing the adhesions, tying the singular vessels, till the rectum is made movable to the extent required to bring down a healthy portion of it, or, if necessary, of the sigmoid colon, without traction, to the skin level. The still unopened gut hangs out of the wound, and we first close the peritoneum on its front and sides; then we stitch loosely the sphincter to that healthy segment of the intestine which is in contact with it, taking care to approximate the divided muscular fibres. We close the external wound and drain it, and only now the bowel is sectioned at the level of the skin and its mucosa connected with sutures to it. In this way no contact of septic material with wound or hands is possible, the sphincter with its nerve supply is preserved; ample room is given for the operation. Should the intestine come under tension to the skin, Witzel advises to pull up the sphincter, putting a silver stitch on each side through the ischiosciatic ligament and the skin in front of the sphincter; but in cases of stricture where the dissection is difficult and not always exact, if the intestine is under tension, the risk of checking the circulation is great, I prefer to stop the perineal operation, being fully persuaded that a further dissection and mobilization from this way is too irregular and dangerous for the circulation, and if possible, in the same day, open the abdomen, free the intestine, ligating the superior hæmorrhoidal artery and its sigmoid branch in the right way: that is, avoiding cutting or interfering with the arch anastomosis from which only the circulation is maintained. Should the patient not be fit for this amount of work, the intestine is attached provisorily high up near the sacrum, the wound plugged, and an abdominal operation performed later. The artificial anus guarantees full asepsis of the wound.

Whenever an high involvement of the intestine has been previously ascertained, the radical treatment has to start deliberately from the abdomen. Having cleaned the bowels with great care for some days, and having, immediately before the operation, exactly plugged and aseptically covered the artificial anus, under spinal analgesia a median incision is made to expose the sigmoid colon. Lifting it up we can soon decide the point at which the intestine has to be cut, and from here upwards begins its mobilization. With a long loose sigmoid, and not very extensive lesion of it, the mobilization can be done without cutting it transversely; but in opposite conditions the work is more easily performed by dividing the sigmoid at the upper limit of the disease, between ligatures, avoiding any soiling of the field, and infolding both ends with suture. The upper end is pulled out, the peritoneum of its meso is cut on both sides and the vessels exposed. First is the superior hæmorrhoidal artery, which has to be cut, taking care to put the ligatures above the point at which it receives the principal arch anastomosis from the sigmoid artery which is a branch of the hæmorrhoidal itself or of the arteria colica sinstra. If necessary, this too must be cut, and it can be done without danger to the circulation, if the section of the mesentery keeps far from the arch anastomosis, since through this the circulation may be preserved even if the inferior mesenteric artery should be ligated. But this is not necessary, since it is only its branches radiating from a centre which keeps the intestine in a circular position, and as soon as they are cut the circle stretches into a straight line. If the arch anastomosis is injured the circulation stops, therefore especial care has to be devoted to that anastomosis between the hæmorrhoidal superior and the sigmoid branch, this being the less rich point in the whole system, as Sudeck and Archibald have demonstrated.

The bowel can in this way be stripped off the iliac and lumbar fossæ, as far as the splenic flexure. This section of intestine too can be made free if necessary as high as to pull down the transverse colon, by cutting its attachments (phrenocolic and splenic ligaments) or dividing adhesions. The mobilized bowel is wrapped up in a warm saline towel and the excision of the distal part is begun from above downwards in the usual way till level with the levator ani muscle, and cutting the peritoneum all around. At this point it is better to stop the abdominal work and start from the perineum, according to the technic already described, removing the whole diseased intestine. Now the mobilized colon is grasped from below with a long forceps by an assistant, who pulls it down and sutures it to the sphincter and to the skin, while the operator from above tries to close with peritoneum the denuded iliac and lumbar fossæ, and the bottom of the pelvis, and sutures the abdominal wall.

To perform comfortably this operation there is required a position of the patient such that the upper body being inclined as for laparotomy and lighted from above, the perineosacral region should be freely exposed to the light with legs slightly flexed and well abducted through articulated supports.

As far as I know this combined operation has never been performed before for strictures and, it may be, not deliberately in this way even for cancer. I first performed it, not so technically complete, in 1903, and five times since in the last three years, with three deaths. This high mortality is surely a great drawback, and I will not legitimate the operation by saying that future improvements and familiarity with the technic will make it safer. I have only to observe that for many cases this operation is the only one possible, and, if successful, gives full guarantee for the future, which is not true even for the most extensive operation in case of cancer.

I have tried the operation three times in two stages. First, removing the rectum from the perineum and suturing the upper stump to the sacral wound, and secondly freeing the colon from the abdomen and bringing it down to the anus; but in these three death followed.

As to the function of the intestine, it cannot be expected to be at once perfect, on account of the many well-known changes in the innervation and muscular action which always follow a rectal extirpation, but I can state that the patients have been highly satisfied and their health completely changed. A small plastic operation aiming to a more exact union or apposition of the cut sphincter ends, and to a narrowing of the intestinal opening, can be later safely performed when the circulation of the implanted bowel cannot be imperiled any more.

In conclusion, I believe that in cases of stricturing proctitis or proctosigmoiditis the treatment is to be as follows:

1. Cæcal anus and laparotomic exploration of the bowels.
2. Perineal or combined removal of the diseased section, in one or two stages, with mobilization of sigmoid and colon if necessary, and preservation of sphincter.
3. Closure of cæcal anus.
4. Plastic operation, if necessary.

I wish to emphasize the importance of resorting more frequently to the abdominal route in the treatment of strictures of the rectum for the purpose of preliminary exploration, and the importance of exact ligating and cutting the arterial supply from the abdomen, even in cases of perineal operation, to prevent any damage to the circulation.

LITERATURE.

References to the literature have purposely been avoided in this memoir, but I feel obliged to mention the following papers from which many technical suggestions have been derived.

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THE OPERATIVE TREATMENT OF FRACTURES.*

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I HOPE to put before you clearly and briefly my views of and experience in the treatment of simple fractures.

I was originally led to resort to operative procedures by finding, from the dissection of bodies whose bones had sustained fractures, that the fragments when displaced had hardly ever united in anything approaching accurate apposition, and that definite changes took place in those joints whose functions were affected by the alteration in the physiology of the skeleton resulting from such imperfect replacement of the broken fragments.

A careful inquiry into the results of the treatment of fractures by splints and manipulation confirmed the experiences of the dissecting room and showed that the consequent joint changes meant depreciation in physique and the wage-earning capacity of those who had to engage in laborious pursuits. These views met with violent opposition till the discovery of X-rays proved that the first contention was true, while the law courts are steadily impressing on the profession, in a costly manner, the disabilities which are associated with imperfect restoration in the form of broken bones.

In 1894 I read before the Clinical Society of London my first paper on the results of the treatment of simple fractures by operation, and I contrasted them with those obtained by other means. Since that time I have continued to operate on all simple fractures in which I was unable to bring the fragments into satisfactory opposition when the circumstances of the patient required it.

During the last seventeen years, I have operated upon a very large number of recent fractures at all ages, from early infancy to extreme old age, with the same uniform success. I have employed various methods at different times, endeavoring to devise means of fixation of the fragments in accurate apposition which shall be at the same time effectual and easy of application. I soon recognized that if the treatment by open operation was to become general it was necessary that the procedure should be rendered as uncomplicated as possible.

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* Delivered before the American Medical Association, June 9, 1909.

The difficulty that has beset this treatment is that, if a foreign body is left in a wound the surgeon must be infinitely more careful about asepsis than he is in the ordinary course of events and careful in a degree proportionate to the bulk of the foreign body. Judging from what I have read on the subject, it would also appear that the methods of the antiseptic surgeon, as contrasted with those of the surgeon who practices asepsis, are prejudicial to success. It is because of insufficient aseptic precautions and to some extent from a want of familiarity with the use of wire, screws, etc., that we hear so many complaints of the development of rarifying osteitis about a screw or wire perforating a bone, of screws working loose and consequently becoming ineffective for the purpose for which they were employed, and of the employment of such futile methods as ivory pegs, etc.

With the exercise of greater cleanliness and with an increasing manual dexterity these troubles will cease to arise. Why a surgeon should not be governed by the same principles by which an ordinary skilled mechanic works I cannot understand, but I presume that the surgeon has rarely had any such training as would fit him for this kind of work. Curiously enough, the opposition to such operative procedures which continued with such intensity for so long, seems to have suddenly diminished because several surgeons have broken loose from tradition and have satisfied themselves that by operation alone can the greatest measures of success be obtained.

I do not propose to discuss the various methods I have adopted for retaining the fragments immovably in accurate apposition, but will confine myself to describing those which I now find most effective for the purpose.

The locality of the incision should be carefully chosen, to avoid damage to important structures and especially to nerves, and to reduce to a minimum the chance of subsequent infection of the wound. In the lower extremity there is no risk to important vessels, tendons or nerves, but in the arm the conditions are very different, and every precaution must be taken.

To ensure asepsis, which one can do with certainty, an incision of ample length is made. Several folds of gauze are attached to the edges of the skin incision by means of fenestrated forceps specially constructed for the purpose. They are long and heavy enough to fall away from the wound and do not require to be held.

The forceps used to control hemorrhage exert pressure upon the bleeding vessels sufficient to permanently obliterate their lumen. By their use the necessity of the introduction of the gloved hand into the wound for the purpose of tying a ligature is avoided. The danger of the rubber glove is the possible presence of a puncture through which infection might enter the wound. The hæmostatic forceps are very long, so that the handles fall free of the wound.

All instruments employed for manipulating fragments, holding swabs, plates and screws, for drilling bones and driving in screws are also very long and very powerful, in order to avoid any contact with the wound of the portion of the instrument grasped by the hand, since the gloves are liable to be damaged in the powerful manual efforts which are sometimes necessary to restore the broken bone to its original form.

In considering the means by which accurate apposition of fragments are effected, we must take into account the nature of the fracture and whether one or two bones are involved. Besides this, comminution often adds greatly to the difficulty of the operation.

In torsion fractures the surgeon must remember that in proportion to the overlapping of the fragments so there exists between and separating the surfaces which have to be brought into apposition an increasing quantity of muscle, since the chisel-shaped fragments diverge from one another as they overlap, burying themselves in the surrounding soft parts.

Any one who is imbued with the old creed and unfamiliar with operations on recent fractures, would imagine that to effect apposition all that is necessary is to exert traction upon the distal fragment of the broken bone by pulling on the limb, the trunk being secured, and that by means of this traction the fragments can be drawn from their beds in the soft parts and the fractured surfaces placed in accurate contact.

In the case of spiral fractures of the long bones of the lower extremity, in which this variety of fractures is the most common, no amount of traction which can be exerted on the limb is sufficient to overcome the over-riding of the fragments. This is due to the resistance offered by the bruised and swollen soft parts which surround the fractured bone and from the point of view of traction on the limb form inextensible ties in its length. This applies equally to fractures produced by direct injury, the resistance to replacement varying with the extent of overlapping of the fragments, the amount of extravasation of blood, the laceration of soft parts and the consequent inflammation.

To effect apposition in spiral fractures it is necessary to divide or displace all soft parts intervening between the fragments, to carefully clean away any clot or soft tissues from the fractured surfaces and especially from the retreating angles of the fragments, and to exert traction on the limb, supplementing that traction by forcible apposition of the fragments by powerful forceps, which are so manipulated as to glide the inclined plane of one fragment upon the other. This gliding of the fragments is facilitated by the introduction of a narrow flat blade with a serrated edge to prevent it slipping between the fragments. This, when rotated upon its axis, by its powerful leverage action moves the fragments held together by the forceps upon one another.

In the case of a fracture of a single bone, as the femur, which has been broken by direct injury, the extent of the overlapping of the fragments is from the nature of the injury and the mode of causation of the fracture usually much less. Still, the damage sustained by the surrounding soft parts or ties in the length is correspondingly greater, since in the torsion fracture the injury which the muscles sustain results solely from the fracture, while in that produced by direct injury the soft parts are lacerated and bruised by the impact of the force which determined the fracture, and only to a small extent from the forcible displacement and overlapping of the fragments.

In a fracture of the femur produced by direct injury, traction alone exerted on the limb does not appear to influence the over-riding of the fragments. The fragments can most readily be brought into apposition by so manipulating the limb that the extremities of both are made to protrude through the incision and can be manipulated till the inner margins of the fractured surfaces are brought in contact with one another. Each fragment is grasped with forceps, and while the limb is slowly and steadily extended the opposing edges of the ends of the fragments are levered on one another till the broken surfaces come into accurate apposition, when the axes of the fragments are in continuity and the bone is restored to its normal form.

This difficulty does not exist to the same extent in fractures of the upper extremity produced by direct injury, since the ties in this limb are less bulky and tense than in the leg, and, from the nature of things, spiral or torsion fractures are of comparatively rare occurrence in the humerus, radius or ulna, though they are not infrequent in the metacarpals.

The difficulty of effecting accurate apposition is very greatly increased by the presence of comminution, which can make a considerable demand on the skill and ingenuity of the surgeon. This complication produces most obstacles in the case of the spiral fractures, since every aspect of the fragments is very oblique and much is necessarily out of sight and there is no surface or point on which one fragment may be made to pivot or impact on the other.

Perhaps the most awkward complication one may have to meet is great fragility of the fragments, such as appears to exist to a great extent in alcoholics and to a lesser degree in feeble children and in old age. But this concerns the retention of the fragments in apposition rather than their reduction.

Delay in operating renders the replacement of the fragments more difficult because the shortened soft parts or ties become rapidly less extensible and a correspondingly greater force is required to stretch them. This is a serious matter if the bones are fragile or comminuted. The operation should be undertaken as soon as the skin can be effectually cleansed.

As to the best means of retaining fragments securely in apposition when the fractured bone has been restored to its normal form, I would point out that in certain fractures, as in those about epiphyseal lines, there is usually no tendency to a recurrence of the displacement once reduction has been effected, providing the part is put up in a position the reverse of that in which it was produced. For instance, in a Colles' fracture either through bone or through the junction of the shaft with the epiphyseal line, after replacement of the fragment by manipulation or operation the hand is retained in a position of extreme flexion and adduction, which is also the extreme position of usefulness. It is well to remember that if the surgeon has to employ any means for retaining an epiphysis in position, as, for example, in separation of the lower epiphysis of the femur, he should insist on the removal of the rigid connecting medium after union has been effected, otherwise it will control the growth in the epiphysial line and deformity will result. In a case of a complicated fracture through the inner half of the epiphyseal line of the lower end of the femur, objection was made to the removal of the staples which were employed to retain the fragment in position, because of the condition of the patient. Later this patient developed a bowed leg.

There are occasions on which it is necessary to rely on screws alone, as in the case of fractures of the neck of the femur and in some spiral fractures, but in the vast majority of cases I prefer to use as long and as strong a steel plate as possible, carrying as many screws as space permits. To reduce the difficulty of finding the drill hole in the distal compact layer of bone, which is frequently of no avail when the fragment is comminuted, I employ screws of a length only sufficient to engage the proximal compact tissue and threaded up to the head in order to secure as firm a hold as possible on the bone. For this purpose I use screws in two lengths—½ and ⅝ inch, and in two gauges, Nos. 5 and 7. In the young infant I employ ⅜ and ½ inch screws in No. 3 gauge.

The fewer the varieties of screws employed the smaller is the number of drills and consequently the less complicated the operation, since each gauge of these modified screws requires only one drill. By this means I have reduced enormously the difficulties of securing the fragments immovably in apposition. In simple fractures I hardly ever use wire. I would exclude from this the fractures of infancy when two or more weeks have been allowed to elapse between the receipt of the injury and the operation. In such cases the distal fragment loses its density at a very early period, and while the proximal fragment will hold the screw securely, the thread will get no secure grip of the distal portion because of its friability. In these circumstances I supplement the junction by encircling the plate and distal fragment with a loop of silver wire.

The operative measures which are required in the treatment of badly united fractures are similar except that the fragments have to be cut through in two distinct planes in fracture of a single bone and in four planes in fracture of two bones such as the radius and ulna or tibia and fibula, in order that the axes of the fragments can be rendered continuous. These operations are very much more difficult and are accompanied with more risk from hemorrhage than are recent fractures. The results obtained are also very rarely as good, because of the changes which develop in the joints whose functions have been affected by the faulty junction. I think that with better initial treatment such cases will soon cease to exist.

Whatever the extent of the shortening in badly united fractures, the surgeon should endeavor to correct it entirely or to reduce it as much as possible. There is, as far as I am aware, no limit to which the muscles, nerves, vessels, etc., can be stretched if only sufficient force can be exerted on the fragments. Such operations may make a very great demand on the skill and resources of the surgeon, and an increasing familiarity with them will enable him to obtain an increased measure of success.

A CLAMP FOR THE FIXATION OF UNUNITED FRACTURES.

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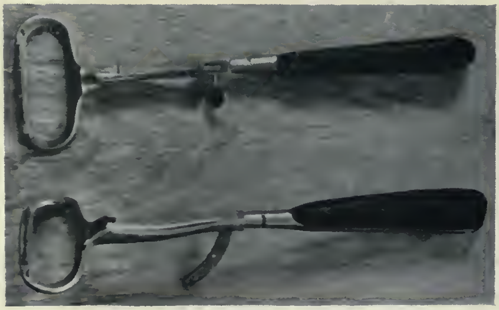
Because it had always appeared to me unsurgical to leave permanently buried in the tissues anything indestructible for a considerable time, I was on the outlook for some appliance which would hold together fractured bones till union had occurred, and which was then removable. The case of a young man whose femur had been wired with success five years previously, strengthened my desire, for his femur refractured at the site of union while he was walking in the street, and exploration showed that the bone had become so softened for some distance around the wire as to allow of this. The softened bone could be cut with a knife.

My late house surgeon, Mr. R. J. Willan, took up the matter with enthusiasm, and to his ingenuity I am indebted for a clamp which has served me so well that I think it should be better known.

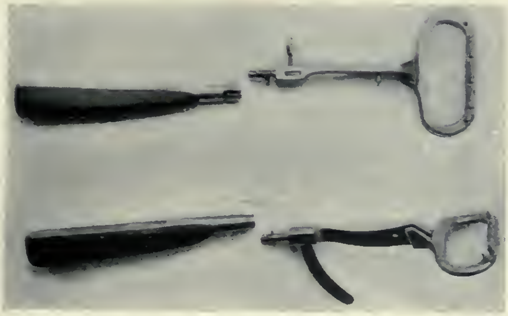
Description of Clamp.—The clamp is made up of two halves which are fixed together by a detachable joint. Each half consists of an oblong rim of thick tough steel with rounded corners, and with its surfaces flattened from side to side, the whole being slightly convex on its outer side and concave on its innermost side. From the middle of one long side of the oblong, and welded to it, projects the handle of the instrument, also made of steel, and one inch above the junction of the handle with the oblong portion is the site of the joint between the two halves of the clamp. Upon the inner surface of the portion of the rim opposite to where the handle is attached, five steel teeth are firmly fixed. The three central teeth project inwards three-sixteenths of an inch; they are half an inch broad and are wedge-shaped on section; the remaining teeth are conical and also project three-

FIG. 1



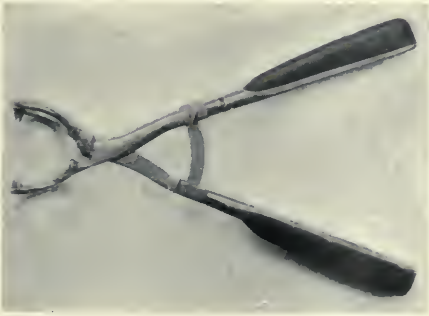
Clamp with blades separated.

FIG. 2



Four separate portions of clamp.

FIG. 3



Clamp ready for use.

sixteenths of an inch. The free edges of these teeth are sufficiently sharp to grip firmly the surface of a bone when the clamp is applied. The handles are 3¼ inches long, and are made so that detachable handles of equal length can be affixed, a greater purchase thus being obtained in the clamping of the bone at the operation. The mechanism for screwing the clamp, when it has successfully grasped the bone ends, is a ratchet with a set screw. The size of the oblong portion varies according to the bone to be clamped; the teeth and handles (fixed and detachable portions) are the same in all. The two halves of the instrument are united by a joint which is detachable in order to facilitate removal.

Operation.—The technic of the operation was the same in each of the following cases. The bone ends were exposed through an incision parallel to the long axis of the bone. The fractured ends were refreshed previous to their being manœuvered into position for the application of the clamp. In an ordinary case the operation can be quickly performed. It is necessary to follow certain rules in the application of the instrument. Of the five opposing pairs of teeth, two pairs must grasp the lower fragment, two pairs the upper fragment, and the remaining pair will be in the neighborhood of the site of fracture. Moreover, the teeth must grasp the bone about half way between its anterior and posterior aspects. If the clamp has been properly applied, the fragments are quite firmly held together. The detachable handles are then removed and the wound sutured excepting for the point of exit of the fixed portion of the handles. An ordinary dressing followed by many layers of sublimated wood wool covers the wound and buries the clamp, and the overlying bandages are starched. A supporting splint is then applied to the limb and the dressing is not disturbed till the clamp requires removal (in from 6 to 8 weeks). For this purpose it is necessary to give an anæsthetic, and partially open the wound, when the clamp can be rocked out by means of the handles. The second wound has always healed in the course of a few days.

Case I.—T. D., aged 51, a coal miner. Twenty-seven weeks before admission to the Royal Victoria Infirmary, Newcastle-on-

Tyne, patient was struck on the right arm by the iron socket of a broken haulage rope, fracturing his humerus. His arm was kept on an internal angular splint, with a short splint at the site of the fracture, for eight weeks. As there was non-union at the end of this time the bone ends were wired together by an open operation at another hospital, and a splint was in addition applied for nine weeks. Upon admission on October 19, 1907, there was an ununited fracture of his right humerus at its middle. The clamp was applied and *left* on for nearly three months, when it was removed. This man has an arm so strong and useful that he is now following his employment as a coal-hewer.

Case II.—N. H., aged 57, a coal miner, was admitted in January, 1908, with an ununited fracture of the middle of his right femur. He had broken the bone ten months previously by a miskick at a football. He was treated by the application of a long Liston splint and extension for three months; but there was no union. He had used crutches ever since for locomotion. Upon admission there was marked deformity of the limb, with an ununited fracture of the middle of the femur, movement between the fragments being very free. There was shortening of the leg to the extent of 3½ inches. The clamp was applied for eight weeks and then removed in the usual way. The man is now in full work as a coal-hewer.

Case III.—J. W., aged 24, a motorman, was admitted in March, 1908, for disability of his right arm. He gave a history of having broken his arm three and one-half years previously owing to backfire of the motor. It was treated with splints for nine weeks. There was an ununited fracture of the ulna at the junction of its middle and lower fourth. The clamp was applied and left on for twenty-eight days, when it was removed. The bone was united. This patient's wage-earning power is now equal to what it was prior to the accident.

Case IV.—W. P., aged 43, a coal miner. Eight months before admission, while at work in the mine, a fall of stone fractured his right femur. The treatment employed was immobilization by a long Liston splint, together with extension, for six weeks. This was followed by the application of plaster of Paris, which was kept on for a further eight weeks. At the end of this time, as there was still no union, the long Liston and extension treatment was resumed and continued for a further six weeks without any union resulting. Upon admission, in October, 1908, there was an ununited fracture of his right femur at the junction of the middle and lower thirds, with deformity, marked loss of function, and great shortening. The bone ends were clamped in good position and at the end of two months the instrument was removed, there being perfect union. The patient is now doing his ordinary full day's work as a coal-hewer.

Case V.—H. D. H., aged 28, a coal miner. Fourteen weeks before he came into hospital his right arm was run over by a tub, and both bones were fractured. The arm was splinted for six weeks in a semi-prone position, after which time massage and passive movement were employed. On admission he was a strong, healthy man. There was an ununited fracture of the right ulna, about the junction of the upper and middle thirds, and at the site of the fracture there was a false joint. Both supination and pronation were limited. The clamp was applied on January 2, 1909, and it was removed six weeks later, when there was firm osseous union. He has returned to work with a useful arm.

MUSCULOSPIRAL PARALYSIS COMPLICATING FRACTURE OF THE HUMERUS.

AN ANALYSIS OF THE CASES AT THE MASSACHUSETTS GENERAL HOSPITAL.

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INJURY to the musculospiral nerve is a serious accident, and its various phases demand careful consideration. Comparatively few cases of injury to the musculospiral nerve with fracture of the humerus are recorded. No practitioner sees many such injuries. It is a lesion that is overlooked, and is often discovered unexpectedly. The outcome of the operated cases of musculospiral injury complicating fracture of the humerus is not generally known to practitioners. During the past few years several exhaustive monographs chiefly from French and German sources have appeared upon the subject.

Because of the above facts, a careful study of the literature has been made by us and also an especial analysis of the cases of musculospiral paralysis occurring at the clinic of the Massachusetts General Hospital. The conclusions to be derived from this study are of considerable practical importance.

Historical.—The existence of musculospiral paralysis accompanying fracture of the humerus was undoubtedly recognized by surgeons of old. So far as we know, however, little was ever done for such complications beyond caring for the fractured bone. Some fifteen years elapsed after the discovery of ether anæsthesia before measures were instituted that revealed the condition of the nerve and looked to the restoration of its integrity.

In June, 1863 von Busch did the first operation to free the musculospiral nerve after a fracture of the humerus. The nerve was released from new tissue which enveloped it and rapid recovery followed in a few weeks. Later in the same year, September, 1863, Ollier in a case of upper arm fracture cleared the paralyzed musculospiral from encroaching new tissue and was rewarded by a cure. These two men were the pioneers in the field; other surgeons followed their practice, and material for statistical inquiries accumulated.

Frequency of Occurrence.—In 1886 v. Bruns collected 866 cases of humeral fracture of which 22.2 per cent. were at the proximal end, 53.1 per cent. were in the shaft, and 24.7 per cent. were at the distal end.

In 1899 Riethus collected 319 cases of fracture of the humerus and found 35.4 per cent. were of the proximal end. 33.6 per cent. were of the shaft, and 31.0 per cent. were of the distal end.

It will be noted that fracture occurs with about the same frequency in each third of the humerus in Riethus' cases, but in v. Bruns' tabulation the middle third has a preponderant percentage. Riethus also noted that 161 of his collection were fractures of the right, and 158 of the left humerus.

Musculospiral paralysis of some degree existed in 73 cases, 8.4 per cent. of the 866 collected by v. Bruns; in 48 of the 73 the location of the fracture was in the upper third of the humerus 4 times (8.3 per cent.), in the middle third 25 times (52.1 per cent), and in the lower third 19 times (39.3 per cent.).

In Riethus' 319 cases 13, or 4.1 per cent., were complicated by musculospiral paralysis. Of these 13 the fracture was of the upper third in 1 case (7.7 per cent.), of the middle third in 9 cases (69.2 per cent.), and of the lower third in 3 cases (23.1 per cent.).

On the basis of these figures it can be stated that musculospiral paralysis is an infrequent complication of fracture of the humerus and occurs chiefly in fractures of the middle third of the bone; less frequently it occurs in fracture of the lower third, and rarest of all it occurs in fracture of the upper third of the humerus.

The general subject of paralysis of the musculospiral nerve will be alluded to only as it is helpful to a more satisfactory knowledge of the nerve lesion in connection with fracture of the humerus. The paralysis of this nerve associated with fracture differs from other paralyses of this nerve chiefly in etiology. The symptomatology and indications for treatment may present identical problems. It is possible to have a musculospiral paralysis in a case of fracture of the humerus from causes entirely independent of the fracture.

Moreover, the fracture of the humerus is not the only bone fracture which may damage the musculospiral nerve: ulnar fracture in the upper third has been attended with symptoms pointing to involvement of the posterior interosseous nerve.

Anatomical.—The musculospiral nerve pursues its course through the upper arm in close relation to a solid structure—the humerus—and maintains its closest relation with the bone and periosteum in its middle third. The nerve is not imbedded in soft tissues. Moreover its course is spiral, thus subjecting itself peculiarly to traumata resulting from displacement of fragments. The chances of injury to the nerve by tension or pressure, though lessened in some degree on account of the nerve running in a bony groove, are increased by this anatomical arrangement in case fracture and displacement occur. Especially is this true if the nerve is held firmly to its groove by natural tissues or overlying muscle. These features of the anatomy are most potent causes for occurrence of a pathological rarity—a nerve caught between the fractured surfaces of a bone.

Before the nerve enters the groove or just about at that point, it gives off three cutaneous branches which are described as supplying the upper arm; these branches run more in the muscle tissue and preserve their function in the large majority of traumatic paralyses of the musculospiral.

In attempting to explain the integrity of musculospiral sensation so frequent in fracture with motor loss in this nerve, Fessler has been led to believe the sensory supply to the radial half of the dorsum of the hand leaves the nerve above the fracture and escapes functional impairment by its course in soft tissue.

This anatomy of the sensory supply can hardly be accepted as final. Several authors have been puzzled to explain lack of sensory loss on an anatomical basis. Goldstein suggested that the ulnar nerve carried the sensory fibres; others thought there existed a sensory supply of the radial distribution through other routes.

Primary and Secondary Paralysis.—In separating cases of musculospiral paralysis associated with fracture of the humerus into classes Riethus has been chiefly followed. He made two broad divisions based on the time when symptoms of nerve involvement appear. Thus they are (1) immediate or primary, and (2) secondary.

A further subdivision of the primary cases is made by Goldstein into (*a*) the nerve is damaged by the injury, (*b*) the nerve is damaged by the bone.

The symptoms of nerve impairment appear immediately in the primary cases and stress is laid on the importance of examining every fractured humerus with reference to neural integrity. Many times after the recognition of paralysis of the musculospiral nerve, uncertainty of its duration has had to be admitted by the attending surgeon.

The secondary cases are those in which musculospiral paralysis develops from nerve compression or stretching during the course of osseous repair. Fessler further divides the secondary cases into (*a*) those occurring during the healing process, and (*b*) those subsequent to fracture healing; in the latter variety necrosed bone, a pseudo-arthrosis, or a fistulous tract may be the cause.

Musculospiral nerve injury may complicate fracture of the humerus at any age and has been known to occur with obstetrical fracture; infants and adolescents present numerous examples of paralysis (Broca and Mouchet). In these cases at early ages no special point of fracture is found responsible for musculospiral paralysis.

Etiology.—The principal factor in the etiology is the anatomical relation of the musculospiral nerve to the humerus, especially in the middle third of the bone.

In the primary cases coincident with or immediately following the fracture, the nerve may be contused, stretched, divided partially or completely, pinched between the fractured ends, or be impaled by a splinter. Goldstein believes generally there is complete rupture of the nerve at the time of the break and in 20 primary cases found complete division in 12. In 13 cases of children Vennat reports 3 cases of complete division; Bruns found that about 8 per cent. of paralyses were due to partial or complete tearing of the musculospiral nerve. Riethus in 8 cases of primary paralysis found the nerve divided in 3 instances.

The secondary cases are comprised largely in one class, namely, callus inclusion * of the musculospiral nerve which by pressure, as is generally assumed, impairs the function of the nerve till even total paralysis is developed; or if the callus gives a free tunnel for the nerve it undergoes stretching to a degree that suspends more or less completely its functions. Even if the nerve is not included in the callus tissue but is pushed before it, the course of the nerve over the rounded mass may result in a stretching with loss of function.

In 55 cases Blenke reports 35 secondary cases, or 63.6 per cent. This may perhaps be accepted as approximately the proportion of secondary cases.

Symptoms.—The symptoms of musculospiral involvement at the time of fracture or during repair are largely of motor impairment or loss. The forearm extensor muscles controlling the wrist and digits lose either partially or completely their power; and some degree of anæsthesia may be established in the radial nerve supply. Chiefly the sensory loss is found on the dorsum of the hand between the metacarpal bones of the thumb and forefinger, the so-called " punctum maximum " of anæsthesia. It is remarkable to what a degree sensation is retained; Fessler's views of the anatomy have already been referred to by which he explains this integrity of sensation: he attributes it to the more superficial course of the cutaneous branches which leave the trunk of the nerve above the fracture and carry, as he believes, sensation to the radial half of the dorsum of the hand. On the basis of this anatomy Fessler further asserts that immediate sensory loss from tearing of the nerve indicates that the fracture is above the middle of the humerus.

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* Savariand believes contusion of the nerve is the most frequent cause of paralysis and that it is spoken of least.

In general the sensory symptoms have no relation to the degree of motor loss. It is said that sensory disturbance follows primary paralysis only and that secondary paralysis has no sensory disturbance (Fessler).

The symptoms are largely motor; the muscles paralyzed are: extensor ossis metacarpi pollicis, extensor communis digitorum, extensor carpi radialis, extensor carpi ulnaris, extensor longus pollicis, extensor brevis pollicis, extensor indicis, extensor minimi digiti, and supinator longus and brevis.

The position assumed by the arm and hand in musculospiral paralysis is flexion of the fingers at the metacarpophalangeal joints with ulnar abduction and slight flexion of the wrist; the thumb is adducted and the forearm pronated.

In primary paralysis or paresis the onset is as sudden as the break of the bone. The secondary cases may develop insidiously with formications and sharp pains along the nerve and functional failure by degrees along with the compression.

No definite time can be set when the callus interferes with nerve function, but in a general way it is in the second week or later. It is important to ascertain whether a period of preservation of function of the nerve immediately follows the fracture. The motor and sensory disturbances set in practically simultaneously in secondary cases (Riethus).

Trophic disturbances are rare but atrophy may occur and in exceptional cases the nails, skin, and cellular tissue may show nutritional deterioration.

Callus incarceration of the musculospiral with total paralysis may be attended with neuralgic pain especially on movement. Bruns, however, says irritation and paralytic symptoms may be wanting with the nerve incarcerated.

From callus irritation the perineurium may proliferate in a spindle-like thickening, forming a sort of neuroma. On the other hand the nerve may be flattened and thinned (Blenke).

Prognosis.—The prognosis in a general way is favorable to recovery in the large majority of cases which have had the benefit of operative procedure. According to Bruns 50 per cent. of all cases require operation. Murray claims that in 37 cases he freed the nerve 34 times without suturing, and in 3 cases he sutured the nerve, with almost uniform restoration of function. Kramer believes the prognosis is good; he had 35 cases with only 3 bad results. Blenke had 41 cases of perfect healing, 6 cases almost perfect, 8 cases with considerable improvement and 3 cases showing little improvement. One case with unfavorable result presented a divided nerve with ends lost in the callus at the time of operation, 6 weeks after fracture. Blenke believed success would have been attained if operation had been resorted to earlier. In other cases he believed the interval before operation too long.

Some cases have been operated on a second and a third time. There exist records of cases operated on 16 months, and 3½ years after fracture with restoration of nerve function. In general the longer the duration of paralysis the less favorable the prognosis.

The time of improvement after operation varies from a few weeks or even days, to months; generally it begins in 3 to 4 months and final cure is completed in about a year's time. One case (Riethus) with resection of the humerus recovered in 2 years, improvement setting in first after one year.

Cases are recorded of quick return of sensation in one day, in 2 days, and 8 to 10 days after operation. The general law seems to hold true for the musculospiral that sensation returns before motion after paralysis of both.

Electrical reactions in some measure are of prognostic aid, but their value is limited because they cannot indicate the pathological condition. A complete reaction of degeneration is more unfavorable than a partial one, and though it would make the prognosis grave is by no means a contraindication to operation. But a change in the character of the reaction of degeneration is perhaps of most significance, being unfavorable when the negative current response of the muscle is less than the positive. Most favorable is the presence of Faradic response in the nerve, which however is usually subsequent to evidence of voluntary return.

Indications for operation.—What are the indications for operation in musculospiral paralysis complicating fracture of the humerus and its healing? Every case of paralysis, whether primary or secondary, requires careful study as to the question of operation. The pathological condition of the nerve is the vital point and, unfortunately, similar symptoms may attend a varied pathological condition; there is not even a pathognomonic symptom of complete division of the nerve.

Of more importance than the fact of some failure of function in the musculospiral is the time it has persisted and whether it is getting less or increasing. Many cases have recovered without operation; Bidder has two cases cured without operation; 8 out of 17 of Riethus' cases got well without operation. Many other cases are reported in which exploration was unnecessary. On the basis of the foregoing, Blenke says operation is not immediately necessary but a case should be handled expectantly; if primary paresis persists and increases then operate. Von Bruns states that if 4 to 6 months pass without improvement operation should be resorted to. Riethus asserts that secondary paralyses never recover spontaneously, so that operation is always indicated in this class of case. Moreover, it should be done early, though late interference has proved beneficial. Schreiber states that a case of primary paralysis should not be operated if the symptoms are not increasing. A case of Ollier's is referred to in which by manipulation of the bony fragments (extension and circumduction) he is said to have freed the nerve.

The Röntgen ray has been of great service. First of all it demonstrates the position of the bones. Good alignment would assure the surgeon that the nerve was not on a stretch continuously. A large shadow of callus would be of corroborative value in secondary cases. The information as to the nerve is indirect, for after all we have to infer what may have happened to the nerve from what is found as to the condition and position of the bone.

The results of electrical findings are of some aid in demonstrating the degree of paralysis present, and may be of the greatest help in determining functional restoration or impairment. But the pathological condition and the pathological future of the nerve are the essentials to be determined as nearly as possible; and the knowledge of the electrical reactions helps only a little. A contusion cannot be distinguished by the electrical reactions from damage due to callus or even a complete division of the nerve.

Vennat, however, believes that electrical reaction of the affected parts determines treatment: if a partial degenerative reaction persists, or the reaction is good, no operation should be attempted; but if there is complete reaction of degeneration operation is indicated.

Treatment.—In the treatment of these cases the question of operation requires conservative consideration. If a given case is going to get well with treatment other than resection, suture, or operative release of the nerve, operative interference is not required. On the other hand if permanent paralysis of the extensors is inevitable unless the musculospiral nerve is dealt with surgically, operative procedure is demanded. But such definite knowledge is not attainable in every case In the consideration of individual cases we should approximate as nearly as possible this ideal attitude before rendering an opinion as to operation.

A careful operation, even if unnecessary, would not interfere materially with ultimate recovery, while an error in failing to operate would be most regrettable. So it seems advisable on the whole to favor surgical investigation in cases in which doubt exists.

The time of operation is to be chosen at as early a date after symptoms of paralysis appear as possible. The later degenerative changes in both nerve and muscle are thus reduced to a minimum; and the progress of a partial, but increasing, paralysis may be arrested.

Indications for or against operative procedure turn after all on the pathological diagnosis. The more severe the trauma the greater the probability of some tearing through the nerve or even complete division, especially if there has been much rotation of the peripheral fragment, or it has been for a moment pulled apart from the proximal fragment, or the two fragments have been displaced out of line or at an angle; and in such a position the nerve on the stretch may be worn through by an edge of bone (Czerny). Such conditions, as well as that of being caught between the fractured surfaces and transfixion by a splinter of bone, are among the rarer complications pathologically; but if they exist, operation is imperatively required at an early stage.

If in primary paralysis of the musculospiral attending fracture of the humerus the anatomical continuity of the nerve is assured, nature can be relied on to restore function provided that the tension on the nerve is not abnormal and compression by new tissue is not superimposed in the process of repair. Good and gentle adjustment of the bony fragments largely insures against the nerve being kept on the stretch continuously. The complication of callus compression cannot be specially guarded against. If partial recovery of a primary paralysis is followed by a recurrence of the paralysis during callus formation we should then have to turn our attention to the consideration of it as a case of secondary paralysis.

Secondary paralyses of the musculospiral embrace the larger number of cases. A partial and moderate paralysis not increasing and with a partial reaction of degeneration offers the best chance for restoration of the nerve without operation. Again, if a stage of improvement sets in it would be wise not to interfere surgically but try to cause absorption of the callus and cicatrix by massage and electricity so as to free the nerve (Neugebauer).

Increasing paralysis, however, especially if it becomes complete, justifies surgical exploration—or rather demands it. Moreover, a condition of paralysis that is stationary would indicate operation.

In primary cases a divided nerve is to be sutured; if any condition is found that keeps the nerve on a stretch, readjustment of the bone fragments is indicated; if the nerve is caught between bony surfaces * it is to be made free; and impaling splinters should be removed. Resection of the humerus may be necessary to approximate nerve ends; but Blenke condemns the method of Hoffa—an oblique osteotomy—as two points are thus presented at which callus may injure the nerve. Ollier separated the periosteum to avoid new callus in one case. In all cases a proper bed for the nerve must be provided.

The secondary cases have received more attention by ingenious operators in their efforts to prevent repetition of compression. In most cases a clear channel is, to be sure, made for the nerve by simply removing compressing tissue. Latterly, however, the nerve has been further safeguarded by adjusting soft tissues, muscle, fat, or fasciæ about the nerve in such a way as to render impossible recurrent callus enclosure and pressure.

Just what the detailed operative procedure in both primary and secondary paralyses will be cannot be determined beforehand unless the operator obtains an accurate conception of the pathological conditions.

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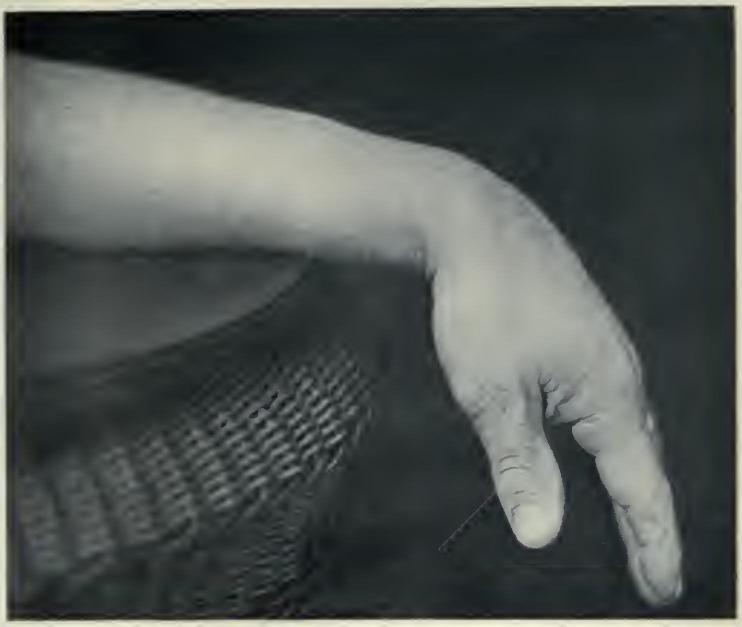
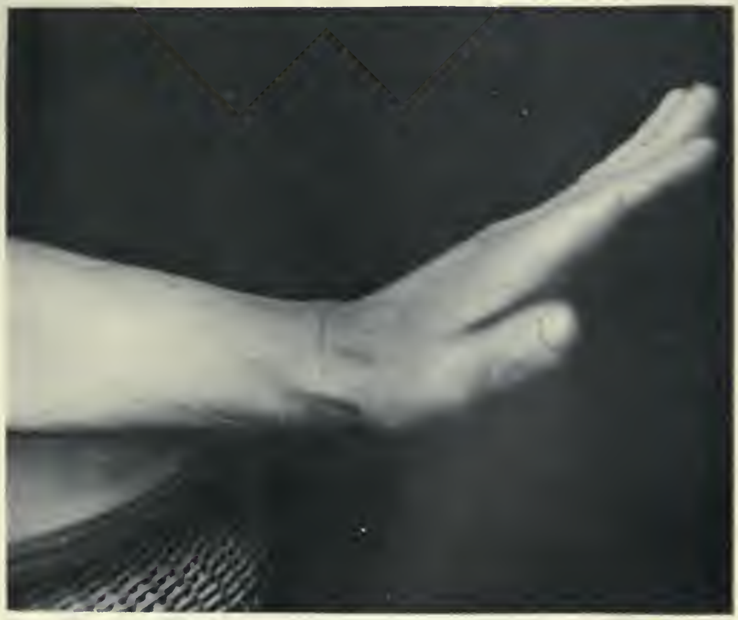
* Pseudarthrosis due to retention of the nerve between the fractured ends of the bone has been observed by Blenke.

Fig. 1.



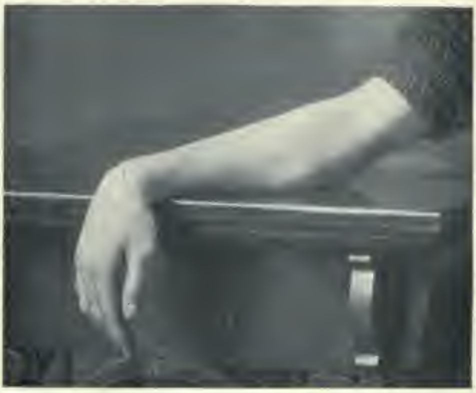
Case II.—Nine years after suture of musculospiral nerve. Note hand hanging prone and muscles relaxed. (Case of Dr. M. H. Richardson.)

Fig. 2.



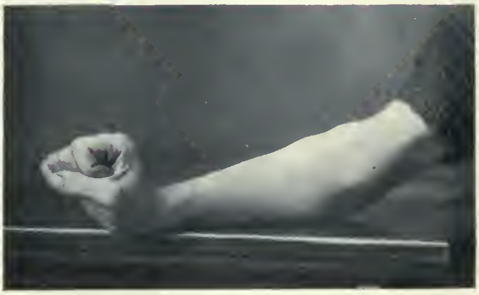
Case II.—Nine years after suture of nerve. Note extensor muscles firmly contracted extending the wrist. (Case of Dr. M. H. Richardson.)

FIG. 3.



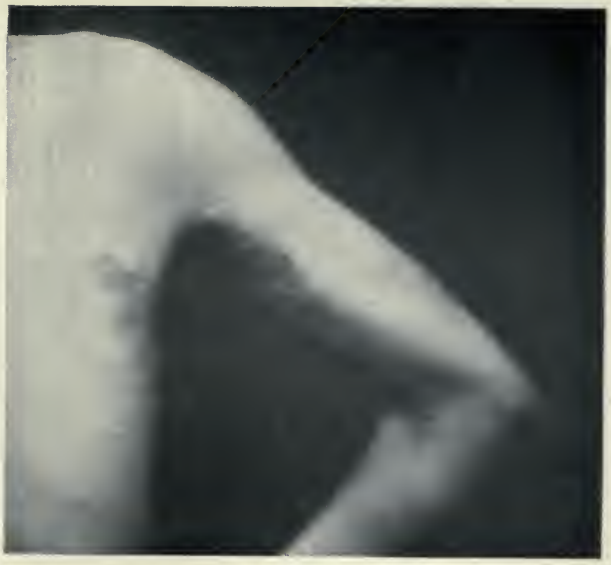
Case IV.—One year after suture of musculospiral nerve. Note relaxed position of hand.

FIG. 4.



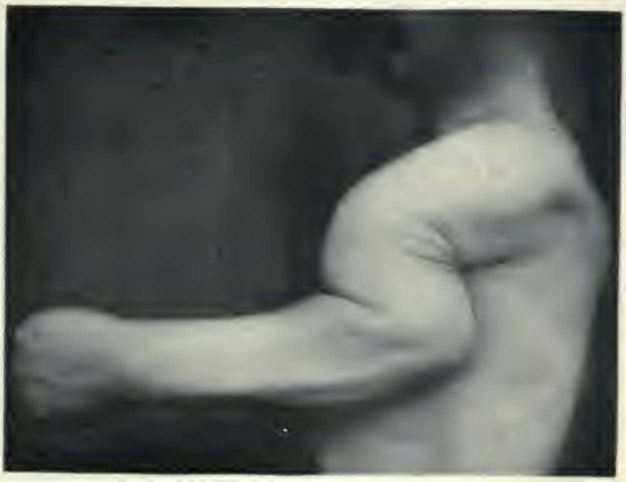
Case IV.—One year after suture of the musculospiral nerve. Note powerful extension of wrist. (Case of Dr. H. H. A. Beach.)

Fig. 5.



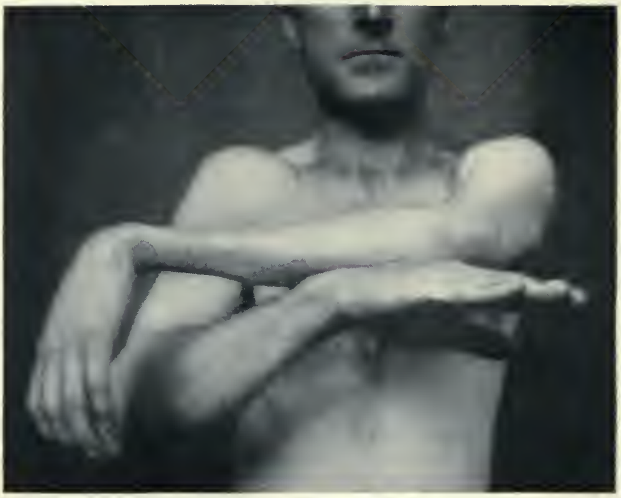
Case IV.—Note the situation of cicatrix locating lacerated wound of upper arm which damaged musculospiral nerve.

Fig. 6



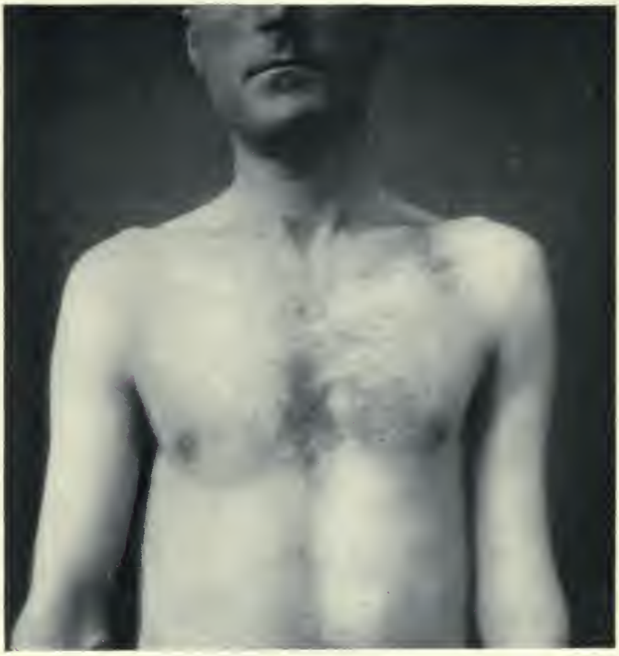
Case VII.—Note ununited humerus twelve years after injury. Muscles seen in powerful ontraction. When muscles are at rest the arm hangs straight at the side. Wrist-drop is still present.

Fig. 7.



Case IX.—Note left wrist-drop sixteen years after accident. Note atrophy of forearm and hand muscles.

Fig. 8.



Case IX.—Note atrophy of shoulder and upper arm muscles.

TABLE I.

Cases of musculospiral paralysis from the Massachusetts General Hospital Surgical Clinic.

No.	Sex. Age.	M. G. H. Record.	Date and kind of injury.	Nerve injury. When discovered. Occasioned by what	Surgeon.	Date of, and operation.	Result and date of observation.	Remarks.
1	Male 19 yrs.	V. 383, P. 146	May 1, 1901. Arm caught to middle in belt of engine	Discovered May 30, 1901. Divided by bone	S. J. Mixter.	September 21, 1901. Nerve found divided, connected by fibrous band. Ends freshened, sutured	No wrist-drop, and gained strength fast. Improvement first noticed one year after operation. September, 1902.	At present at work as a fireman.
2	Male 38 yrs.	V. 656, P. 291	December 16, 1896. Rupture	Rupture	M. H. Richardson.	May 22, 1897. Nerve found divided. Ends freshened and sutured	Nine years later. Excellent result. Motions at wrist slightly limited. Elbow limited about 20°. Finger motions good. Able to work without hindrance. Dec., 1906.	
3	Male 57 yrs.	V. 431, P. 227	Jan., 1903. Fracture	Discovered February 15, 1903. Callus	M. H. Richardson.	April 7, 1903. Nerve found involved in callus. Bone chiselled away and nerve freed	Five years later. Musculospiral fully recovered. March 10, 1908.	
4	Male 13 yrs.	V. 122, P. 291	Oct. 11, '05. Pierced by gunshot	Scar tissue. One shot in nerve	H. H. A. Beach.	January 18, 1906. Nerve freed from cicatricial tissue. Nearly cut across. Sutured	One year latter. No pain; no wrist-drop; no limitation of motion of arm. O. K.	X-ray showed shot in tissues about the nerve.
5	Male 29 yrs.	V. 374, P. 128	Aug. 5, 1897. Mult. fractures	Callus and scar tissue	M. H. Richardson.	1st. operation, July 1900. Musculospiral nerve freed from adhesions. 2d operation, Aug. 1900. Ulnar and median nerves freed from callus. 3d operation, July, 1901. Wired radius	Six years later. Hand and arm perfectly useful. Wrist movements about one-half normal. Little and fourth fingers nearly stiff. Median nerve normal. Ulnar nerve slightly impaired.	
6	Male 29 yrs.	V. 331, P. 44	April, 1900. Comp. fracture, middle lower third	Discovered at time of injury. Divided by bone	....	July, 1900. Nerve ends found separated some distance and much atrophied. Freshened and sutured	No improvement. Died, October 29, 1903.	
7	Male 33 yrs.	V. 564, P. 139	July, 1893. Fracture (caught in shafting. Firm union in 6 weeks)	Discovered after union. Bone and callus	....	February 7, 1895. Nerves freed from callus and sutured	Humerus ununited. Some atrophy of arm muscles. Marked wrist-drop.	Dec., 1893, bone resected, no union. Feb., 1895, wired humerus. Feb., 1899, wired, nerve not seen. Feb., 1907, wired.
8	Female 25 yrs.	V. 526, P. 111	November 27, 1905. Fracture at middle	Immediately noted. Bone and callus	E. A. Codman.	December 16, 1905. Nerve dissected free and sutured	Perfect functional result. Slight hyperesthesia backs of thumb and second finger. Slight bowing at site of fracture. Dec. 5, 1906.	
9	Male 15 yrs.	V. 534, P. 293	Oct., 1890. Comminuted fracture. (Caught in belt)	Callus	....	1st. operation, Feb. 21, 1891. Nerve resected and sutured. 2d operation, idem bone section. Nerve found bulbous at suture line	Union good. Poor functional result. Wrist-drop complete. No elbow flexion.	Seat of fracture upper and lower thirds, lower and middle thirds.
10	Male 25 yrs.	V. 257, P. 22	Nov., 1889. Fracture; machinery crush	Immediately noted. Bone and callus	J. Homans.	June 3, 1890. Nerve freed from callus	Some increase of motion in hand. Abduction of thumb. Complete extension of wrist. Dec., 1906.	
11	Male 51 yrs.	V. 34, P. 82	March 2, 1899. Fracture. Much comminuted. Middle third	Discovered April 24, 1899. Callus	S. J. Mixter.	April 27, 1899. Nerve freed from callus. Resected and sutured	Makes all motions except extension of thumb. 1 year 7 months after operation. Nov. 22, 1900.	

In an analysis of the Massachusetts General Hospital cases the following facts are of importance.

There is a total of 11 cases in which the end results are known. The important facts in these cases are tabulated in Table I. In Table II are placed the same cases showing the time that elapsed between the date of operation and the accident and between the date of operation and the last observation of the patient together with the functional result recorded at the last examination.

TABLE II.

Cases of musculospiral paralysis, Massachusetts General Hospital Clinic. Tabulated according to time elapsed.

No.	Date of accident.	Date of operation.	Interval between accident and operation.	Result and date of last observation.	Interval between oper. and final observ.
1	May 1, 1901	September 21, 1901	4½ mos.	Sept., 1902. No wrist-drop. Improving.	1 year
2	Dec. 16, 1896	May 22, 1897	5 mos.	December, 1906. Excellent result.	9 years
3	January, 1903	April 7, 1903	3 mos.	March, 1908. Perfect result.	5 years
4	Oct. 11, 1905	January 18, 1906	3 mos.	January, 1907. Perfect result.	1 year
5	August 5, 1897	(1) July, 1900 (2) August, 1900 (3) July, 1901	3 years	1907. Good functional result. Movements about half normal.	7 years
6	April, 1900	July, 1900	3 mos.	October, 1903. No improvement.	3 years
7	July, 1893	Dec., 1893, bone Feb., 1895, nerve Feb., 1899. bone Feb., 1907, bone	1 year, 7 mos.	February, 1907. Marked wrist-drop.	12 yrs.
8	Nov. 27, 1905	December 16, 1905	3 weeks	Dec., 1906. Perfect functional result.	1 year
9	October, 1890	February 21, 1891	4 mos.	April, 1907. Wrist-drop complete.	16 yrs.
10	Nov., 1889	June, 1890	7 mos.	December, 1906. Fair result. Extension of wrist possible.	16 yrs.
11	March 2, 1899	April 27, 1899	3 weeks	November 22, 1900. Perfect result, except extension of thumb.	1 year, 7 mos.

Eight cases of the 11 have no wrist drop at present. Three cases showed no improvement in the nerve function following operative interference.

Of these 3 cases, 1 died three years following suture of the nerve, showing no improvement in the nerve function; another (see photograph of Case VII, Figure 6) has had three unsuccessful operations for ununited fracture of the humerus at intervals of six to eight years; the third case had at the first operation the nerve freed, resected and sutured, and at the second operation the bone shortened by resection, the nerve, found bulbous, resected and sutured. After 16 years there is no return of function in the nerve.

Eight of these cases were badly injured. The trauma was very severe; the arm was caught in the shafting or the belt of an engine, or had received a gunshot wound, or was crushed by machinery. Most all the cases were operated upon some three or four months following the accident. The longest interval between accident and operation was three years. This case recovered functional usefulness and the musculospiral supply. Improvement in these cases was first noted six months to one year following the operation.

SUMMARY.

1. Musculospiral paralysis occurs in from 4 to 8 per cent. of cases of fracture of the humerus.

2. Fracture of the middle third of the humerus is the fracture most commonly complicated by musculospiral paralysis.

3. Fracture of the humerus at any age may be associated with musculospiral paralysis.

4. Musculospiral paralysis is primary if it dates from the accident and it is secondary if it is subsequent to the accident.

5. Primary paralysis of the musculospiral nerve indicates a more severe injury to the nerve than does secondary paralysis.

6. The diagnosis of the exact pathological condition of the musculospiral nerve following trauma to it is of the greatest importance and is difficult to determine.

7. Progressive impairment of function or stationary paralysis of the musculospiral nerve complicating fracture of the humerus justifies and may demand operation.

8. Operation means the release of the nerve from compression or tension and often resection and suture, and always guarding against recurrent compression or stretching.

9. A late suture (months after the injury) is attended by

technical operative difficulties not present in an early suture (soon after the injury).

10. Resection of the humerus to allow of approximation of the divided ends of the musculospiral nerve is a good procedure (Allis, Philadelphia) but not until nerve suture *à distance* has first been carefully employed.

11. Electrical reactions cannot determine the pathological condition. They are of value in determining the course of events.

12. The prognosis after operation is good; the earlier a necessary operation is done the speedier the cure.

13. Exercise of paralyzed muscles by electric stimulation (galvanism) is helpful.

14. Sensory symptoms are variable; in general the sensory symptoms have no relation to the degree of motor loss.

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NOTE ON PARTIAL NEPHRECTOMY.

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THE operation for partial nephrectomy is so rarely possible that a single instance seems worthy of record.

I published my nephrectomies, numbering 39 in the ten years which terminated March, 1907,[1] and since that time I have probably done some 12 others; but this is my first partial removal of the kidney. Twice I have been inclined to attempt it, but on second thought have resorted to the complete removal of the organ. One of those cases in which partial nephrectomy was tempting, was a hypernephroma of small size limited to the lower end of the kidney. This has already been published with an illustration in the ANNALS OF SURGERY, vol. xliii, 1906. Although the whole kidney was removed, a local recurrence occurred in about a year,—a recurrence which I should undoubtedly have credited to mistake of my own if I had performed a partial removal of the kidney. Another case, one of tuberculosis of the kidney, also offered a pit-fall. There was a perfectly circumscribed cold abscess about the middle of the external border and apparently well shut off from the pelvis. It would have been very easy to take a wedge out of the middle of the kidney, but I have always felt unfavorably inclined to partial operations for tubercular disease in an organ like the kidney, and therefore followed my usual rule of complete nephrectomy, which was shown on the examination of the specimen to be fully justified by the fact that infection of the pelvis and the ureter already existed.

The details of the present case are as follows:

J. M., female, aged 35, was admitted to the General Hospital under my care on January 10, 1909, complaining of pain in the left loin. She had suffered for the last four years from attacks of pain in the same position at intervals of three to four months, the pain starting about the level of the left iliac crest and shooting upwards as far as the lower ribs. It was of a sharp stabbing nature, generally lasted for some days, and was worse when the patient was up and about than when she was lying in bed. The patient felt sick with the pain, but did not vomit. There was no pain on micturition, or any marked frequency in the day, but she used to get up twice in the night. Examination of the urine showed the presence of pus in considerable and of blood in very slight quantities; the amount of urea was generally about 300 grains or rather less; no tubercle bacilli could be detected.

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[1] British Medical Journal, July 13, 1907.

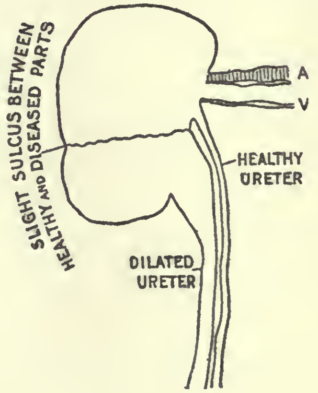
On palpation the patient was tender over the lower part of the left kidney. Muscular rigidity was marked, so that it was impossible to say with certainty whether the organ could be felt; but it was thought that the lower pole could be palpated and that it was enlarged.

On cystoscopic examination the right ureter was found to be normal. On the left side a normal ureter was found in the normal position, functionating healthily. A second ureteral orifice was then discovered further outwards on the left ureteral bar. This was much larger than the left orifice first mentioned, was very patulous, and no efflux was discovered from it. An attempt to catheterize the ureter unfortunately failed, as the only catheters available were too large to be passed down the particular cystoscope in use.

The patient was now given a general anæsthetic and the left kidney exposed through the loin by the usual oblique incision. Dense matting fixed the lower half of the kidney, and it was with great difficulty that it was brought down into view. It presented the appearance shown in Figure 1. The upper portion of the organ, exactly two-thirds of it, was unusually firm in consistence but otherwise apparently quite healthy; the lower third was in a condition of complete sacculation and presented a yellowish-white color in contrast to the brownish-red of the upper healthy portion. The pelvis of this lower third was much dilated, as was the ureter also (to the size of a No. 14 E catheter). No stone could be detected in the pelvis or ureter. The latter was therefore opened and a bougie passed easily into the bladder, showing the absence of stone or stricture. After considerable search, the second ureter was found clinging closely by dense adhesions to the diseased ureter and dilated pelvis. Much trouble was required to separate the two, and it was feared that the nutrition of the healthy ureter might have been damaged. The dilated ureter was now clamped and divided. A clamp was next placed on the vessels of the kidney and the lower third of the kidney excised. Lest any renal tissue should be left on the truncated lower end of the upper healthy portion, that end was carefully curetted with a Volkmann spoon, and the end was whipped over with a continuous catgut suture. The clamp was now removed from the vessels; very little bleeding occurred. The remaining portion of kidney was returned into the loin and the wound closed except for a drainage opening.

Shock after the operation was extremely marked, much more so than in an ordinary case of nephrectomy for a pyonephrosis. This was due probably in part to the difficulty of stripping out the kidney in the first instance and probably to some extent also to the rather prolonged nature of the operation which occupied much more time than an ordinary nephrectomy.

Fig. 1.



The patient's recovery was interrupted by a slight febrile disturbance on the ninth day, two days after the drainage tube was taken out, and was probably due to some little leakage from the cutting out of the continuous catgut suture. There was at this time a little hæmaturia. The patient is now quite well in all respects.

The removed portion contained pus and showed a single cavity continuous with the dilated pelvis. Renal tissue was almost completely absent and a section of the walls of the sac failed to find evidence of tubercular infection.

PARTIAL RESECTION OF THE BLADDER FOR MALIGNANT TUMOR BY THE TRANS-PERITONEAL ROUTE.

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The treatment of new growths in the urinary bladder has not been satisfactory. This remark applies not only to malignant growths, but also to the so-called benign ones. Of the latter it is commonly believed that there is a tendency for a simple growth in the bladder to take on malignant characteristics.

The statistics published by Watson [1] indicate with sufficient force the unsatisfactory results of operative treatment. Watson studied 653 cases (243 benign, 410 malignant). These had been under the care of different surgeons. He had found that where a more or less radical operation had been performed for papilloma and myoma, 34 per cent. only were free from recurrence at the end of one year. After similar treatment for carcinoma only 28 per cent. were free from recurrence at the end of a year. He further holds that if operative deaths and rapid recurrences are considered together under the head of "operative failures," such failures have appeared in 28.06 per cent. of benign and 46 per cent. of carcinomatous tumors.

Numerous methods have been adopted for the removal of bladder growths. Operative cystoscopy with the use of the snare or galvanocautery has been employed of recent years. The writer had an opportunity of seeing Casper, of Berlin, during the past summer, operate upon a growth in the bladder by means of the cystoscope. He was removing a tumor from the bladder of a man 72 years of age. This was being accomplished piecemeal, a small portion of the growth being removed every few days by a wire snare. Casper explained that as the man had patience and sufficient time at his disposal, he approved of this method of operating rather than that of suprapubic cystotomy in a man of his age. Perhaps Casper's attitude towards this patient may be explained by the conclusions to which he has arrived as published in his book on "Genitourinary Diseases," where he states that "patients do better and live longer without than with operation."[2]

From time to time tumors of the bladder have been attacked by suprapubic cystotomy. On exposing the tumor it has been removed by free dissection, the use of the galvanocautery, the employment of a wire snare, or a combination of these methods. In some cases X-ray treatment through the bladder opening has been suggested. In the suprapubic operation, as carried out in the past, two main dangers are emphasized by those who have operated along these lines. The first of these dangers is infection of the prevesical cellular tissue (Retzius's space); the second is infection of the peritoneal cavity. Curiously enough, until within the last few years surgeons have dreaded the opening of the peritoneum in operations on the bladder rather than the disturbance of the prevesical space. The writer is firmly convinced that this attitude is entirely erroneous, and from his experience would be inclined to state that the opening up of the prevesical cellular tissue is a very much more frequent cause of serious complications in bladder surgery than is the opening of the peritoneal sac. Infection in the prevesical space is an exceedingly serious complication, particularly in old people with atheromatous vessels. Further, it is much easier to prevent infection of the peritoneum when the bladder is opened by the transperitoneal method than it is to prevent infection of the prevesical space when that is widely exposed during operative procedures upon the bladder.

My paper deals with a case of carcinoma at the base of the bladder. For this condition, in which the treatment hitherto has been so eminently unsatisfactory, total extirpation of the bladder has been advocated of late years. Rovsing of Copenhagen recently reports[3] before the German Association of Surgeons three cases in which he performed this operation.

By this method the bladder is removed through a suprapubic wound and the ureters are carried out into the loin through the space of Petit, where subsequently the urine is discharged. He has succeeded in performing this operation without wounding the peritoneum. The first patient, 34 years of age, was still alive and well when he reported the case eleven months afterwards. The second, a man of 67 years of age, died on the eighth day after the operation; the third, a man aged 57, was alive at the time his case was reported, four weeks after operation. Mayo has advocated the transplanting of the ureters into the rectum in such cases. Paroliks transplants the ureters into the vagina in the female and Sonnenberg carries them into the urethra.

Berg,[4] in the ANNALS OF SURGERY, September, 1904, proposes the removal of the bladder by the transperitoneal method. After opening the abdomen the peritoneum of the pelvic floor is divided straight across. Each ureter is traced down to the bladder and the tumor is removed. The ureters are transplanted into the healthy part of the bladder if they have been involved in the growth. Further, any lymph-glands which may be involved are dissected out from beneath the peritoneum in the pelvis. Drainage is provided through the pelvic floor into the vagina in the female or between the prostate and rectum in the male. The bladder is sutured and the peritoneum is closed over the pelvic floor and the abdomen closed without drainage. Harrington [5] has reported a case of chronic disease of the bladder treated by the transperitoneal incision.

An important contribution to the subject of the removal of tumors of the bladder has been made by Chas. H. Mayo. He has described a simple and efficient means of operating upon these cases by the transperitoneal route. The abdomen is opened above the pubes and the bladder opened by a vertical incision through its peritoneal covering. The tumor is removed and subsequently the wound in the bladder is sutured. Five cases have been operated upon for papillomatous growths without mortality; three of these tumors were carcinomatous, and the others benign.[6]

The following case was operated upon by me on the 17th of January last and the operative procedure as described by Mayo with but slight modification was carried out. The following is a history of the case:

J. W., aged 48 years, was admitted to the Toronto General Hospital under my care on January 15 with a history that three months previously his symptoms of trouble in the bladder began. This consisted in frequency of micturition, pain, and hæmaturia. He went from bad to worse, until finally on admission his condition was almost desperate. The urgency of the case consisted chiefly in the fact that he had not only lost a very large quantity of blood and was profoundly anæmic, but the blood had collected in the bladder and had produced retention, so that he was suffering great pain. On admission the bladder was found distended to the umbilicus. On passing a catheter blood-clots and urine were drawn off with great difficulty, but it was possible to relieve his distress to a considerable extent by this means, and it was hoped that, within the course of a few days, one could improve the local condition before operating. Rectal examination showed a tumor-like mass in the left wall of the bladder, palpation of which caused the patient much pain. No enlargement of the prostate gland could be detected. With a silver catheter in the urethra thickening was very marked on the left side of the bladder in the region of the seminal vesicle. When seen on Sunday afternoon, two days after admission, the bladder was again greatly distended and the patient was suffering intensely. He had broken out in a cold perspiration and he was loud in his expression of the wish that death would relieve his sufferings. Operation was immediately undertaken for his relief and the following procedure was carried out.

The patient was anæsthetized and placed in the high Trendelenberg position. An incision was made in the middle line from the pubis to an inch and a half above the umbilicus. On opening the peritoneum it was found that the bladder was distended very markedly, so that the prevesical fold of peritoneum was fully two inches above the pubic bone. Several long strips of gauze were placed in position in such fashion that the abdominal viscera were excluded from the pelvis and thoroughly protected. The bladder was then incised through the peritoneum by a vertical incision on its posterior surface three inches long. It contained blood-clot of the color and consistence of red currant jelly. There was no urine distinguishable from this mass, save a small amount of port-wine-colored fluid (perhaps two ounces) which lay in the bottom of the bladder. A portion of the blood-clot was lifted out by the hand and the remainder by a sterile tablespoon, and thus the bladder was emptied. The inner wall was now inspected and a tumor was observed on the floor of the bladder, situated on the left-hand side, forming a patch about 7 cm. in diameter. On close inspection it was found that the ureter entered the lower portion of this mass, the margin of the tumor extending 1 cm. beyond the mouth of the ureter towards the prostate. The right margin of the tumor was about 1 cm. from the middle line. The incision in the posterior wall of the bladder was extended down to within a centimetre of the tumor, and then the whole thickness of the bladder wall, including the peritoneal coat, was cut through to the left and right of the tumor at a distance of 1 cm. from its margin. It was now found that the lowest portion of the tumor lay below and anterior to the line of reflection of the peritoneum on the posterior wall of the bladder; consequently, in order to reach that portion, the peritoneum was divided transversely about 2 cm. above the lowest point of Douglas's pouch. The left ureter was recognized through the peritoneum, and was subsequently found as it passed into the tumor mass anterior to the peritoneum. It was found to be dilated sufficiently to admit a structure the size of an ordinary lead pencil.

The vas deferens was observed passing over the ureter towards the middle line. The mucous membrane was now divided by means of the scalpel 1 cm. below and anterior to the tumor, this incision being carried in a curved direction so as to divide the mucosa 1 cm. from the lower margin of the tumor mass. The tumor was thus completely separated from its connections and was pulled up out of its bed with the ureter still attached to it. The ureter was now divided transversely 1 cm. from the point of its entrance into the tumor mass. On inspection, the bed from which the tumor had been enucleated was found to consist of the floor of the pelvis, in which the fibres of the levator ani were exposed.

The ureter was first of all secured by stitching it to the wall of the bladder as it passed through beneath the peritoneum. The extremity of the ureter was carefully stitched to the mucous lining of the bladder at a point where the cut in the mucosa had been brought together by three or four interrupted catgut stitches. It was thought wise not to attempt complete closure of the mucosa where the enucleation of the tumor had left a bare area in the floor of the pelvis. A raw surface in this locality was consequently left which measured perhaps 4 cm. in diameter. The bladder was now closed towards the peritoneum by a series of No. 2 sterile catgut stitches, the Connell stitch being used, beginning at the bottom of Douglas's pouch and extending all the way on the posterior surface of the bladder to the prevesical fold above. A very successful turning in of the edges was thus accomplished. This closure was supplemented by sterile linen thread, No. 1, from the bottom of Douglas's pouch to the prevesical fold carried as a continuous Lembert suture.

Douglas's pouch was now swabbed out with some warm normal saline solution. The strips of gauze were removed and the abdominal wound closed. A large-sized rubber catheter was left in the urethra for the purpose of draining the bladder. The laparotomy wound was closed by No. 1 catgut in the peritoneum, and then by a series of interrupted silkworm gut sutures, the skin edges being approximated by horse-hair.

The patient made an excellent recovery from the operation. He lost all his pain and distress and passed water freely by the urethra. There was very little hæmaturia and he was soon able to leave the hospital completely relieved.

The case which I have reported illustrates well the possibilities of relief in this serious class of bladder affections. It is somewhat remarkable that the definite procedure which was adopted in this case has not long ago been suggested when so much advance has been made in recent years in the treatment of surgical conditions within the peritoneal cavity. I close this paper with the suggestion that in all probability the future will show that it is much less dangerous to approach the bladder in such cases through the peritoneum than by opening up the prevesical space of cellular tissue. It is possible that ere long the prostate gland may be attacked by the transperitoneal method. The question may well be asked: Why not remove growths from the bladder and subsequently close the opening by bringing the serous surfaces in contact after the manner adopted in connection with tumors of the intestinal tract, or for surgical conditions in other viscera? With proper precautions one may readily believe that the opening of the bladder through the peritoneum is not nearly as likely to result in peritonitis as is the opening of the bowel through its serous coat.

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CANCER OF THE PROSTATE.

A CLINICAL, PATHOLOGICAL AND POST-OPERATIVE ANALYSIS OF 111 CASES.

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PRELIMINARY REMARKS.

Most of the important literature on carcinoma of the prostate is based on autopsy records. Few clinical reports of large series of cases have been published, and our knowledge of the clinical characteristics, the living pathology and the operative indications and results is in a very confused condition. It is generally held that operative attack upon the cancerous gland is injudicious and that hope for a radical cure is out of the question of possibilities.

Six years ago the writer promulgated a radical operation for the cure of cancer of the prostate, and the time seems ripe to see what results have been obtained.

Surprisingly good results in advanced cases have been obtained by palliative operations, and the writer, when invited by Dr. Pilcher to contribute a paper on "Carcinoma of the Prostate" for this memorial volume, decided to present an exhaustive study of his cases with the hope of presenting an accurate picture of the clinical and pathological characteristics of the disease, to show the possibilities of an early diagnosis and radical cure, and to determine the basis of palliative operations and what may be expected from them.

In this series of cases only those have been included for tabulation in which fairly good records were at hand. We have thus collected 111 cases, nearly all of which I have personally seen and examined, the large majority from my private practice.

CLINICAL CONSIDERATIONS.

Etiology.—The ages of the patients were as follows: Under 50 years, 2 cases; 50 to 59 years, 25 cases; 60 to 69 years, 50 cases; 70 to 74 years, 17 cases; 75 to 79 years, 13 cases; 80 to 84 years, 4 cases; total, 111 cases.

As seen here, the greater number of patients were in the decennium between 60 and 69 years of age, 45 per cent. being in that period. Sixty-nine per cent. of the cases were under 70 years of age. These figures correspond very closely to those of benign prostatic hypertrophy, as I found in an analytical study of 145 cases. Forty-six per cent. of the patients were between 60 and 69 years of age and only three of real hypertrophy in patients younger than 50 years of age. The youngest patient with carcinoma was 45 years of age and for eight months had suffered with severe burning in the urethra. For six months urination had been very frequent and difficult and for five months there had been considerable hæmaturia. The prostate, seminal vesicles and bladder were all involved in an extensive carcinomatous growth and the patient died fifteen months later, two and a half years after the beginning of the disease.

The second case, in which the patient was 45 years of age, had had symptoms of pain over the left tuber ischii for six months. Recently he also had pain in the perineum. There had been no hæmaturia and very little difficulty in urination. The carcinoma was confined to the left lobe of the prostate and a small nodule in the right lobe. The cystoscope showed only a small median bar and the bladder was negative. The patient refused operation. This case would have been an excellent one for a radical operation.

It is interesting to note that these figures correspond closely with that first report of Sir Henry Thompson, who in the year 1860 gave the medical world its first definite ideas of carcinoma of the prostate. In his report of 12 cases there was one 41 years of age; two between 40 and 50; three between 50 and 60; five between 60 and 70; two over 70 years of age.

Gonorrhœa.—Thirty patients acknowledged having had gonorrhœa and in 25 cases no record has been made on this point.

Among those patients who acknowledged having had gonorrhœa there were none in which the prostatic trouble seemed to be continuous with that of the gonorrhœa, and the gonorrhœa was cured in nearly all cases many years before the beginning of the final prostatic trouble. One patient, 76 years of age, acquired gonorrhœa six weeks before admission and ten months after the beginning of his prostatic trouble. These figures correspond to those found in cases of benign hypertrophy, there being only 46 patients of 145 who admitted having had gonorrhœa, and in only 8 of these was there a stricture present, 3 alone being severe in character. My statistics seem to clearly disprove Ciechanowski's assertion that the etiology of prostatic hypertrophy is a chronic inflammation.

Marital state.—Eighty patients were married; 27 were widowed, and only 3 were single. In one case no note was made. While it is probably true that only a small proportion of males remain single after 50 years of age it seems true that carcinoma of the prostate, as with hypertrophy of the prostate, is much more frequent among married men.

In my series of 145 cases of benign prostatic hypertrophy only 12 were single and there were 10 cases in which the patients were Protestant ministers, all of them married, and not a single one of 145 was a Catholic priest. That the history of the sexual over-indulgence is not a necessary precedent I know from a few cases in which the patient distinctly declared that he had not had coitus for many years before the beginning of his prostatic trouble.

Heredity.—Unfortunately my case histories are not sufficiently explicit as to the previous existence of cancer in families of the patients to make my records accurate, but it is safe to say that heredity plays about the same importance in carcinoma of the prostate as in cases of carcinoma elsewhere. In one case the history was remarkable in that the great-grandfather, grandfather, father and three uncles all died of prostatic trouble, probably carcinoma. The patient was 54 years of age, and although the onset of the disease was apparently only about five months before admission, the seminal vesicles were already involved so that only a conservative perineal prostatectomy was performed.

Among the 17 cases in which perineal prostatectomy was performed, the family records were quite accurate and there were only 3 in which there was a family history of carcinoma.

Relation between Benign Hypertrophy and Carcinoma.— This will be discussed more fully in the pathology of the disease. We may remark here, however, that in half of the cases the disease is not associated with hypertrophy of any portion of the prostate and that when the two diseases do exist at the same time they are apt to involve different portions of the gland, the carcinoma the posterior and subutheral portions, the hypertrophy the median and central groups of glands.

SYMPTOMATOLOGY.

In this series of 111 cases a careful analytical study of the symptomatology has been made by my assistant, Dr. M. L. Boyd, and is as follows:

In 76 cases the first symptom noticed by the patient was an increased frequency of urination, generally slight in character. In a few cases this symptom was very marked, but in most of these there was an improvement after a few days. In 48 cases difficulty of urination was an initial symptom and was also usually slight at first and became progressively worse. In 4 cases the onset was ushered in with a complete retention of urine and in 4 by hæmaturia— two slight and two considerable. Pain was not an infrequent onset symptom and its location has been tabulated as follows:

POSITION OF PAIN.

	No. of cases
Urinary tract (bladder or urethra)	16
Rectoperineal region	7
Inguinal and scrotal regions	2
Dorsal, sacral or gluteal regions	6
Lower extremities	3
Hypogastrium	1

In most of the cases in the above tabulation the pain was generally quite marked and sometimes very severe. Those cases in which only very slight burning was complained of were not included, though several cases in which the burning was severe and amounted to a pain have been included. There was one patient in which irritability in the bladder was quite marked. One patient, aged 64, was suddenly seized, during urination, with an excruciating pain which radiated from the bladder to the end of the penis, and after that recurred frequently. In another case the onset symptom was pain in one groin and down the back of the thigh, which his physician told him was rheumatic in character and gave him "appropriate" treatment for seven months, when, for the first time, a very slight difficulty of urination was noticed. Only four weeks before admission were his urinary symptoms sufficient to call attention to his prostate, by which time the entire prostate and seminal vesicles were involved in an extensive carcinomatous growth. In another case the first symptom, which came on suddenly two and a half years before admission, was a severe pain in the rectum which became continuous and grew steadily worse. Another patient had had only one symptom since the beginning, three months before—sharp shooting pains in the left hip radiating down the left thigh to the knee and associated with a numbness which extended to the foot. There was practically no urinary disturbance although the membranous urethra, prostate, seminal vesicles, pelvic glands and rectum were involved in an extensive carcinomatous mass.

In my 145 cases of benign hypertrophy the onset symptoms were as follows:

ONSET SYMPTOMS.

	No. of cases
Frequency of urination	88
Difficulty of urination	78
Pain	25
Hæmaturia	7
Complete retention of urine	8
Incontinence of urine	8

In 12 of the 25 cases of benign hypertrophy in which pain was present, there was only a slight burning in the urethra and in 3 the pain was merely the discomfort produced by straining to void. In one case there was sharp pain which followed sudden stoppage of urine during micturition. In 9 cases calculi were present. In no case were there the symptoms of sciatica or severe pain in the hips, buttocks, thighs or groins which have been seen in many of our cases of carcinoma.

Hæmaturia is shown to have been a more common onset symptom in benign hypertrophy than in carcinoma.

In conclusion, it may be remarked that in the majority of cases the onset is much the same as that of benign hypertrophy: an increase in the frequency and difficulty of urination, which is often slowly progressive in character. Pain alone is a much more common symptom and frequently remains for a long time the only symptom. In one remarkable case the first and only symptom complained of was pain in the legs which was found to be caused by an extensive carcinoma which involved also the vessels of the groin.

In 60 cases which were studied by Motz the onset symptom was: difficulty of urination in 38 cases; complete retention of urine in 8 cases; hæmaturia in 8 cases; neuralgia in 5 cases.

Duration and Course of Disease.—Guyon recognized three forms: (1) those with a rapid course, in which the symptoms may have been present a very short time; (2) those following a subacute course, the disease having been present after the tenth or twelfth month; and (3) those following a very slow course with a duration of two or three and even as long as nine years. In 26 carefully studied cases Motz found that 40 per cent. of the patients died within seven months after the onset symptoms, 7 lived over a year, and 6 for periods varying from two to ten years. In making this study we have prepared a table which shows the duration of various symptoms. It is given on the following page.

DURATION OF VARIOUS SYMPTOMS AT TIME OF ADMISSION OF PATIENT.

	Difficulty of urination.	Frequency of urination.	Pain in urinary tract.	Pain in rectum and perineum.	Pain in groin and testicle.	Pain in lower extremities.	Pain in back.	Pain in supra-pubic region.
1 to 6 months	10	9	13	4	..	13	9	4
6 to 11 months	4	5	4	1	1	..	2	..
12 to 17 months	14	12	4	2	3	3	3	2
18 to 23 months	3	3	1	..	..	1	2	..
24 to 36 months	18	22	2	1	1	2	1	2
Over 3 years	.	..	..	..	..	..	1	..
3 to 5 years	4	9	..	2	..	..	..	..
6 to 10 years	6	7	2	1	..	..	1	..
Over 10 years	2	1	2	..	..	..	1	..

As shown in the above tabulation symptoms were present in many cases for prolonged periods,—the longest being 20 years, during which the patient had difficulty of urination and more or less frequent catheterization. There were 5 cases in which symptoms had been present more than 10 years. None of these cases, however, were subjected to prostatectomy, and we cannot therefore say with positiveness that the early symptoms were not due to benign obstruction to urination. Among the 34 operative cases of which we have good pathological notes, there were only 11 that showed definite hypertrophy associated with carcinoma. Among these 11 cases there was one in which the symptoms of urinary obstruction had been present for 11 years and one in which they had been present for five years. In the other 9 cases the symptoms had been present for shorter periods. Among the cases in which there was no hypertrophy the entire prostate being carcinomatous, there was one in which difficulty and frequency of urination had been present for six years and severe pain for five years, and other cases in which frequency and difficulty had been present for three years in 1 case, two years in 2 cases, one year in 3 cases, and six months in 1 case. These statistics are sufficient to show that the course of the disease is very variable in its duration, some cases being extremely rapid and ending in death in less than a year, but in the majority two to three years of duration, many cases extending over three or four years and a few cases over five years.

In the above tabulation is it noteworthy that pain came on much later than urinary obstruction. In only 3 cases of the 111 had pain been present over 10 years; in only 10 cases over three years, and in the majority of the cases under 18 months.

Catheter Life.—In 21 cases the patient had complete retention of urine and had used a catheter regularly for varying periods up to three years. In 13 cases the catheter had been used less than six months, in 5 cases over a year and in 2 cases over two years. In 23 cases although the patient was able to void, urination was so slow, difficult and frequent, that the catheter was used one or more times daily. In 14 of these cases this had been present for less than six months, in 3 cases between six months and a year, in 2 cases over one year, in 3 cases over two years and in one case five years. In 8 cases complete retention of urine occurred occasionally, requiring catheterization, but these patients did not use the catheter every day.

STATUS PRÆSENS.

When the patient was admitted to the hospital the symptoms presented were as follows: Complete retention of urine and catheter life 19 cases. The number of times daily in which catheterization was necessary was as follows: Two times, 2 cases; three times, 4 cases; four times, 2 cases; five times, 1 case; six times, 4 cases; eight times, 3 cases; ten times, 2 cases; twenty times, 1 case.

Incomplete retention of urine but catheter used, 22 cases: once daily 2 cases; twice daily 5 cases; three times 4 cases; four times 5 cases; five times 3 cases; six times 1 case; seven times 1 case; every few minutes 1 case.

In those cases in which urination was possible the difficulty of urination was great in 28 cases; moderately difficult in 6 cases; slightly difficult in 5 cases.

The frequency of urination was very frequent (every few minutes to one hour) in 38 cases; moderately frequent (about every two hours) in 7 cases; slightly more frequent than normal in 13 cases. In 2 cases there was constant dribbling of urine associated with a large amount of residual urine.

Pain.—The location and the severity of the pain present on admission is graphically shown in the accompanying table.

LOCATION AND SEVERITY OF PAIN ON ADMISSION.

	Slight.	Moderate.	Severe.
Urethra	4	4	10
Penis	3	4	11
Perineum	3	5	7
Bladder	4	2	9
Rectum	2	0	10
Groin	1	1	0
Testicle	3	0	3
Hip	2	3	4
Thigh	2	4	8
Leg	2	8	8
Foot	1	1	3
Lumbar	5	3	7
Sacral	2	2	5
Buttocks	0	4	1
Pubic	2	3	5
Renal colic	0	0	0

The regional pains above tabulated most frequently occurred in groups. Of these, the genito-urinary was the most common, and was characterized by pain in the bladder, urethra, and penis, especially during urination. The rectum and perineum were also often grouped together, and the pain there being generally due to pressure from the enlargement of the gland, which was often sufficient to greatly reduce the lumen of the rectum and render defecation difficult. The other groups of symptoms may be classed as referred rather than local. Among them we notice three distinct groups. Those radiating to the groin and testicle, those radiating to the lower extremities, and those radiating to the back, sides and buttocks. The explanation of these pains is probably the same as in cases of chronic prostatis, a reference of painful stimuli to other nerves running into the same segment of the cord as the periprostatic nerves. Motz has held that the presence of these neuralgias always indicates a periprostatic invasion of the disease. There were, however, two cases in which no involvement of the seminal vessels was found in which referred neuralgias were present.

Hæmaturia.—Hæmaturia was present at one time or another during the course of the disease in 16 cases. In 10 of these it had been intermittent and only once considerable in amount. In 3 cases the amount of blood present was moderate and in 6 cases slight. In 6 cases blood was continuously present, in one slight, in 2 moderate and in 3 considerable in amount. In quite a number of cases a slight amount of blood present was produced by the catheter, but these have not been tabulated though it seems probable that in some of the cases given above a catheter was partly responsible for the hemorrhage. Examination of the urine on admission showed blood in only 8 cases, and in 6 of these it was very slight in amount, but in 3 cases it was quite considerable.

Hæmaturia seems to be more suggestive of vesical tumor calculus or a benign hypertrophied lobule projecting into the bladder. It is certainly not so commonly present as in cases of benign hypertrophy of the prostate, as in my series of 145 cases I found it present in 15 per cent. The absence of hæmaturia is due to the fact that carcinoma of the prostate does not invade the bladder except in a small proportion of cases, and is perivesical and pelvic rather than intravesical. It is also interesting to note that there are no cases in this series in which hemorrhage from the penis occurred, although in 3 cases the anterior urethra was surrounded with more or less extensive carcinomatous infiltration, in one case producing carcinomatous priapism.

Loss of Weight.—In 30 cases considerable, in 11 cases moderate, in 7 cases slight, and in 13 cases no loss of weight was recorded. In twenty-eight cases no mention was made on this point. Although in the later stages of the disease the emaciation was profound and rapid, I have seen a great many cases with very extensive and long standing carcinoma which were not associated with any loss of weight and the patient remained markedly active and strong.

Sexual Power.—Unfortunately the notes in regard to the preservation of erections and sexual powers are not very complete and in 64 cases no record has been made in regard to this. The following table shows the condition present on admission as given by patients in cases in which a record has been made.

SEXUAL POWERS.

Erections.	Coitus normal.	Coitus impaired.	Coitus not attempted.	Coitus impossible.
Normal	8	..	2	..
Diminished..	1	4	3	1
Absent	.	..	4	24

While it is true that carcinoma has a much more decided effect upon the sexual powers than hypertrophy of the prostate, as shown by the above table, it is also true that in cases of extensive involvement of the prostate and seminal vesicles there may be no impairment of the sexual powers. One patient, upon whom a radical operation was performed stated, on admission, that erections were normal, coitus normal and indulged in about three times a week, and that ejaculation, though not quite so free as formerly, was not accompanied by pain. In this case the entire prostate was carcinomatous and both seminal vesicles and vasa deferentia were filled with carcinoma cells. In another case, in which symptoms of urinary obstruction had been present for four years and in which the seminal vesicles and prostate were extensively involved, and the radical operation was performed, microscopic examination showed both vasa deferentia and seminal vesicles completely filled with carcinoma cells, the patient reported that intercourse was entirely satisfactory. In 8 cases in which the radical operation was not performed, but careful clinical examination showed involvement of the prostate and seminal vesicles, the patient stated that he was able to have fairly satisfactory intercourse, in some cases the only complaint being that the amount of semen ejaculated was less than normal.

DURATION OF DISEASE BEFORE ADMISSION.

The time elapsed since the beginning of the very first symptom has been tabulated as follows:

	No. of cases
Under 1 year	20
From 1 to 3 years	67
Over 4 years	22
Time not stated	2

Those cases in which the symptoms of the disease were present for less than a year comprise a remarkable group of cases. In 2 the patient had felt entirely well and there was no symptom at all until six weeks prior to admission. The first symptom in both of these cases was slightly increased frequency of urination which gradually became worse. The prostate and both seminal vesicles were extensively involved and in one case the pelvic lymph glands and membranous urethra were also involved. The latter patient lived only one year after the beginning of the disease, which was remarkably rapid in its course. In 2 cases the first symptom appeared three months before admission, and here again the prostate and both seminal vesicles were extensively involved. In both cases the obstruction was so great that suprapubic drainage was required, and one patient died in fifteen months and the other in two and a half years after the beginning of the symptoms. In 4 cases symptoms had been present for only four months. One of these cases began with sudden complete retention of urine and required catheterization afterward. In another case swelling of the left leg was the onset symptom and in fact the only symptom of which the patient complained, due to extensive periprostatic invasion on one side. In 2 cases pain in the hip and thigh was the only complaint. In all of these cases the entire prostate and seminal vesicles were extensively involved and in 2 cases the pelvic lymph-glands were also involved. In 3 cases the disease had been present six months and in 2 of these the prostate, seminal vesicles and membranous urethra were extensively involved. In one case, however, the carcinoma was confined to a portion of the left lobe of the prostate and a small nodule in the right lobe. The seminal vesicles were negative and the case was an ideal one for a radical operation—which was not accepted by the patient.

In contradistinction to the cases showing very rapid progress described above we have a great many cases in which the disease was very slow, as shown in the above tabulation. In most cases, however, the seminal vesicles were completely involved before admission. I have, however, careful records of 11 cases in which the disease had not progressed beyond the lower portions of the seminal vesicles and in some cases not beyond the prostate or even a small portion of the prostate. In 6 cases in which the operation of radical excision was performed the seminal vesicles were found to be entirely free from disease, in 2 cases (which had had symptoms for 1 and 2 years). In these cases both lobes of the prostate were involved but the bladder was healthy. In one case in which symptoms had been present for three years neither seminal vesicle was involved and there was only a small area of infiltration around the lower portions of the vasa deferentia, membranous urethra and bladder being healthy. In the fourth case symptoms had been present for one year and only the lower portions of the seminal vesicles and the anterior part of the trigone were involved. In the fifth case, in which symptoms of frequent and difficult urination had been present for four years, both seminal vesicles were involved throughout but the disease had not progressed beyond them and the bladder was healthy. In 2 cases in which a radical operation was refused by the patients careful clinical examination showed only a partial involvement of the prostatic lobes in both cases, and in one case a small involvement in the lower portion of one seminal vesicle. The membranous urethra and bladder in both were healthy. In one case the symptoms had been present for six months and in the other for six years. There was no hypertrophy associated with either case.

In one case, in which symptoms of frequency and irritability had been present for eight years, the prostate was slightly indurated and very little enlarged. Perineal prostatectomy was performed, and the tissue removed showed chronic inflammation except in one area which was definitely carcinomatous though apparently completely removed. Another case in which symptoms had been present for ten months showed indurated nodules in both lobes which were carcinomatous. In front of these were two enlarged lateral and median lobes which showed benign hypertrophy. The seminal vesicles were negative. In two cases with considerably hypertrophied lateral and median lobes a small area of carcinoma was accidentally found: in one case in a portion of the lateral lobe and in the second in the anterior commissure.

These 11 cases show conclusively that in some instances the carcinoma is slow of growth and remains for a long period confined to the prostate after marked symptoms are present, and that there is therefore often a prolonged period in which a radical operation should give excellent results.

PHYSICAL EXAMINATION.

The condition of the patient was described as good in 43 cases; moderately impaired in health in 17 cases; considerably weakened in 19 cases; markedly cachectic in 12 cases; no record made in 21 cases.

Enlarged Lymph Glands.—In 22 cases enlarged indurated glands were palpable in the groin and in 2 cases in the iliac fossa. On rectal examination enlarged glands were found around the prostate in 3 cases and adjacent to the seminal vesicles in 4 cases, along the lateral wall of the pelvis in 13 cases and in the sacral fossa in 6 cases. No enlarged glands in other portions of the body have been recorded. In only 8 cases was there a failure to note the presence or absence of glands in the groin, so that these figures may be taken as fairly accurate in showing the great infrequency of glandular involvement of carcinoma of the prostate. This is true in regard to both the pelvic and inguinal glands in both of which enlargement has been found present in about 20 per cent. of the cases. When we consider the very extensive enlargement of the prostate and seminal vesicles which was present in these cases it seems remarkable that the lymph-glands were so seldom involved, but our findings correspond to those of Kaufman who discovered in 100 autopsies upon patients dying of carcinoma of the prostate only 27 cases in which there was involvement of the pelvic lymph-glands. It shows the fact that one should not expect enlarged glands before making a diagnosis of carcinoma of the prostate.

Kidneys and Urine.—The specific gravity of the urine varied between 1001–5 in 6 cases; 1006–10 in 10 cases; 1011–16 in 16 cases; 1015–20 in 12 cases; 1020 or more in 10 cases. The microscopic examination showed blood in slight amount in 6 cases; in moderate amount in 3 cases and in considerable amount in 3 cases. Pus was found in slight amount in 14 cases; in moderate amount in 17 cases, and in considerable amount in 19 cases. Casts were recorded in only 5 cases. An absence of urinary infection was only recorded in 17 cases, but this is not surprising since most of the patients were leading catheter lives.

Rectal Examination.—The condition of the prostate, etc., at examination, is shown thus:

Size:	Prostate.	Seminal vesicles			Intervesicular space.	Membranous urethra.
		Both.	R.	L.		
Slight enlargement	16	8	3	2	10	2
Moderate	27	19	3	3	16	8
Considerable	64	39	2	3	37	24
Indefinitely described	4	..	..	..	..	..
Surface:						
Smooth	32	7	1	1	5	..
Rough	69	30	3	3	25	6
Not noted	10	..	..	..	..	..
Consistency:						
Soft	2	..	..	..	..	..
Elastic	1	14	3	5	7	11
Slightly indurated	..	2	2	1	3	..
Moderately indurated	6	3	7	4	2	24
Very hard	78	56	2	2	49	26
Stony	9	9	..	..	10	5
Mixed, soft and hard	10	..	..	..	..	..

Consistence.—In the above tabulation of the prostatic findings the one thing that stands out prominent is the induration. Whereas the large majority of benign prostatic hypertrophies are elastic or even soft there is only one case of cancer which was described as elastic and none were entirely soft (barring two cases spoken of below).

In our series of 145 cases of benign hypertrophy the prostate was described as soft in 56, elastic in 26, firm in 45, moderately hard in 14, very hard in none, stony in none. The marked contrast is at once apparent and it is only necessary, therefore, to say that whenever the prostate or only a portion of it is quite hard it should be viewed with suspicion.

The case in which the prostate was everywhere elastic, was one in which the lateral and median lobes were considerably enlarged by benign hypertrophy, and the carcinoma was confined to a small area (about 1 cm. in diameter) in the anterior commissure, which could not be palpated by rectum. In two cases the seminal vesicles were very hard and evidently markedly involved by cancer, but in the region of the prostate there was a very prominent, smooth, soft almost fluctuating mass, oval in shape and evidently a hæmatoma or blood cyst beneath the posterior capsule. In neither of these cases was operation performed; but in another case in which a perineal prostatectomy was done, a cyst 1 x 1.5 cm. in size, filled with brownish fluid was found just beneath the capsule next to the cancer, and was, I believe, the same process (old hæmatoma), but of a smaller size.

It is the group of 10 cases described above as mixed, soft and hard, that are the most interesting, as it contains many in which the diagnosis was extremely difficult, and often not made except on the operating table and with the aid of stained frozen sections. In all but 2 of these 10 cases perineal operations were performed (radical 2, conservative 6), and the tissues have been carefully examined. In 6 of these benign hypertrophy was present along with cancer. In 2 of these one lobe of the prostate was soft and showed only a benign hypertrophy. On the other side, which was hard, there was a layer of carcinoma between the capsule and the hypertrophied lateral lobe. In three cases the subcapsular " shell " of carcinoma was present also on the soft side, but was thin enough to transmit the elasticity of the hypertrophied lobe beneath.

In one case only one nodule of cancer (about 1 cm. in diameter) was found beneath the capsule on the left side. The rest of the prostate was composed of benign adenomatous spheroids.

In 2 cases, in which the radical operation was done, no benign adenomatous hypertrophy was present, the entire prostate being replaced by cancer. In both of these cases it is difficult to explain the comparative softness of one of the lobes which was noted on several careful examinations. Both were carcinoma simplex—one quite scirrhus in type, and it seems probable that the fibrous tissue, of which they contained considerable, was softer than the epithelial cells which usually comprise most of the substance of cancerous prostates.

In 2 cases, in which a radical operation was advised but refused by the patient, one lobe was almost entirely normal in feel, and did not even suggest adenomatous hypertrophy—was in all probability a normal lobe as yet uninvaded by cancer.

A review of these 10 cases seems to show that the coexistence of benign adenomatous hypertrophy may lead to a modification of the induration usually found in cancer of the prostate when the layer of cancer between the posterior capsule and hypertrophied area is not too thick to transmit the elasticity of the hypertrophied lobe beneath. When no hypertrophy is present the prostate is almost always very hard in those portions of the prostate involved by cancer.

The *induration* usually found in carcinoma of the prostate is of a peculiar incompressible character, entirely different from that seen in tuberculosis and chronic prostatitis, and, as shown above, usually not associated with any areas of softness unless a portion of the prostate be still uninvaded or unless there be an elastic hypertrophied lobe beyond a thin shell of carcinoma. When the entire prostate has become involved the diagnosis is at once apparent. The prostate is usually more firmly fixed in its location by pericapsular adhesions (due to inflammatory infiltration as is often seen adjacent to carcinoma and not necessarily cancerous invasion). Where only a portion of the prostate is involved, and especially where coexistent with hypertrophied lobules, the diagnosis is often very difficult, and in fact impossible; but the presence of such an area of induration should lead to a suspicion of carcinoma, and careful investigation at operation with incision of the suspected area (if necessary) and perhaps stained frozen sections. In such cases the consent of the patient to a radical operation, in case the disease should prove carcinomatous, should be obtained beforehand. As noted above, the enlargement was slight in 16, moderate in 27, and considerable in 64 cases. As a rule when the carcinoma has not spread beyond the prostate there is only a moderate amount of enlargement present and often the prostate is only very slightly enlarged. In most of our early cases this was the condition present, and not infrequently owing to the small size their physicians were apt to consider the prostate negative on rectal examination, even when the disease had spread to the space between the seminal vesicles and bladder. The line of demarcation between the prostate and the extensive transverse plateau of induration above it, is often impossible to outline, and not infrequently the prostate is described as considerably larger than normal, and at operation the enucleated lateral lobes are found to be very little enlarged.

The *surface* of the prostate as indicated above was smooth in 32 and rough in 69 cases. Under the head of rough we have included cases described as irregular, with a nodule here and there, as well as those in which a marked roughness was everywhere present. One of the most surprising findings has been that the surface is remarkably smooth in many cases. This is due to the fact that the fascia of Denonvillers, which extends from the triangular ligament upward beyond the seminal vesicles as a tense fascia closely applied to the posterior surface of the prostate in the anterior of its two layers, makes a firm barrier against invasion towards the rectum. In fact, this fascia remains itself free from invasion generally until late in the disease; but although many of the cases are perfectly smooth, when roughness is present it is usually so entirely different from anything seen in hypertrophy of the prostate that carcinoma should at once be suspected.

In our series of 145 cases of *benign hypertrophy* there was only one case which was rough and nodular and 14 cases in which the smoothness of the posterior surface was distorted by the presence of one or more lobules which projected beyond the confines of the rest of the hypertrophied prostate, in some cases having broken through the posterior capsule, generally at the upper end on one or both sides and thus projecting into the region of the seminal vesicles, and occasionally towards the apex of the prostate where the lobule sometimes encroached upon the rectum. In these cases, however, the lobule was smooth and generally somewhat elastic and entirely different in its appearance from the indurated areas seen in our cases of early carcinoma. In some cases of benign hypertrophy with a history of suppurative conditions, adhesions and irregular areas of infiltration suggested carcinoma strongly, and in one such case the diagnosis of carcinoma was held until after a suprapubic drainage the prostatitis disappeared, and along with it the posterior surface of the prostate became smooth and elastic so that the benign character of the enlargement was at once evident, and demonstrated by perineal prostatectomy.

Seminal Vesicles.—As shown in the above tabulation (page 1158) the seminal vesicles were frequently involved. The seminal vesicles, one or both, were indurated in 88 cases and more or less enlarged in 82 cases. It is probable that both of these figures should be a little larger, as the seminal vesicles were in some cases difficult to reach owing to the thickness of the perineum, the fatness of the patient or the large size of the prostate. Only 14 cases are recorded in which both seminal vesicles were normal in consistence and size, and therefore probably not involved by the carcinoma. These 14 cases are of considerable interest. In all but 2 cases the diagnosis of carcinoma was confirmed by study of tissues removed at operation (radical excision 3, perineal prostatectomy 9). In 2 of the cases, in which the radical operation was performed, although the seminal vesicles were free from invasion there was a small area of carcinoma just above the prostate, beneath the anterior part of the trigone and adjacent to the lower end of the seminal vesicles. In the other case the disease had not spread beyond the upper limit of the prostate. In all 3 of these cases the diagnosis was made before operation. In 2 cases (seen in 1901 and 1903) the malignant nature of the disease was not recognized either before or during the operation (one suprapubic and one perineal prostatectomy), but the microscope subsequently showed carcinoma. In both of these cases the disease had not spread above the prostate and a radical operation should have given good results. In 4 cases in which hypertrophied lateral lobes coexisted with cancer of the posterior subcapsular portion (Fig. 5) the possibility of cancer was considered but disposed of with the statement in each case that, " the induration was not sufficiently great for cancer and the cystoscopic demonstration of intravesical lobes showed that definite hypertrophy was present."

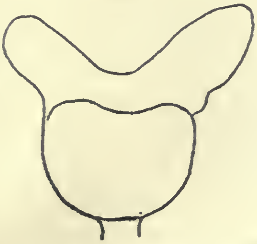
At that time we did not realize that not infrequently carcinoma was associated with benign adenomatous hypertrophies and on that account, the consent of the patient had not been obtained for a radical operation, and therefore (and because of the objection of their atending physicians) the radical operation was not performed, although in all these 4 cases the diagnosis was made as soon as capsular incisions in the prostate were made at operation, and the prognosis for such was good. The 3 remaining cases in which operation was performed are of great interest. In each of them the diagnosis of benign hypertrophy was made and the ordinary conservative perineal prostatectomy performed. In one case a small area of carcinoma, 2 x 3 mm. in diameter, was discovered in one of the lateral lobes, and in the second case a larger area (about 6 mm.) was similarly located. In the third case which came to autopsy soon after operation a carcinomatous nodule 1 cm. in diameter was discovered in the anterior commissure of the prostate. The first 2 patients are alive, one five and the other one and a half years after the operation, and rectal examination seems to show that the carcinoma has been completely removed. In 2 cases the operation was not consented to, although both were extremely favorable cases for radical procedure. In both of these the seminal vesicles were apparently healthy and one lobe of the prostate had not become involved. In 2 cases (not included in the 14 above mentioned) the seminal vesicles were supposed to be free from invasion, but in the specimens removed by radical operation the lower ends were found to contain carcinoma. One of these patients, however, is alive and apparently well four and a half years after the radical operation. He weighs over 200 pounds, has no pain or urinary obstruction, and an examination made by me one year ago showed no evidence of recurrence.

It may be interesting to note here that the duration of prostatic symptoms in these 14 cases had been present in 3 cases six, ten and ten months; in 2 cases one year; in 3 cases two years; in 2 cases three years; the rest of the cases over four years, so that it would seem that *there is often plenty of time in which to make a diagnosis before the disease has spread beyond the prostate.*

As noted in the above table, there were 18 cases in which only one of the seminal vesicles was found to be involved, and in view of the case of apparent cure, detailed above, it would seem probable that in several of these cases the upper portion of the vesicle was free from disease and that a radical operation might have been performed with success.

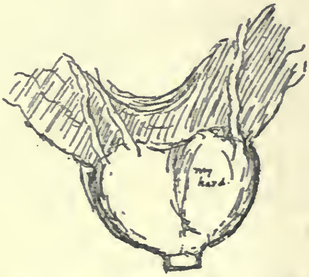
Intervesicular Space.—As noted in the above table, the space between the seminal vesicles above the prostate was involved in a great many cases, and had careful notes in regard to this region been made in some of the cases seen several years ago it is probable that the percentage of involvements of this region would be even greater than that of the seminal vesicles. As a rule, when the disease spreads above the prostate it invades the soft tissues beneath the trigone adjacent to the ejaculatory ducts, the lower ends of the vasa deferentia and seminal vesicles, usually forming a small plateau of induration which, in some cases, occupies a breadth of 1 cm. on each side of the median line. In other cases it extends to the outer side of each vesicle, thus forming a plateau continuous with the prostate and often difficult to distinguish from it (Fig. 1). Further progress generally consists of involvement of the interior of one or both seminal vesicles and the tissues between them and the bladder, thus forming usually a bicornate mass of induration with a sharp concave upper border (determined by the lower limit of Douglas's pouch of peritoneum). The posterior surface of these superprostatic invasions is usually smooth (on account of the strong fascia covering them), but not infrequently they are irregular and nodular (Fig. 2). The induration like that of the prostate is usually very great, often of stony hardness, and the whole mass is fixed by adhesions to the pelvic wall. When a portion or all of the seminal vesicles escapes invasion it may form a soft, somewhat elastic layer between the rectum and the subtrigonal infiltration, and lead to mistake, as in one of my cases in which the radical operation was performed on the assumption that the disease had not progressed far above the prostate. In this case, although the upper portions of the seminal vesicles were healthy, the disease had reached the peritoneum by travelling in the space between them and the bladder. A more careful examination, especially making use of the cystoscope in the bladder and the finger in the rectum, should have demonstrated this.

Fig. 1.



Showing bicornate mass of induration when both seminal vesicles and intervesicular region are completely invaded and adherent to the prostate.

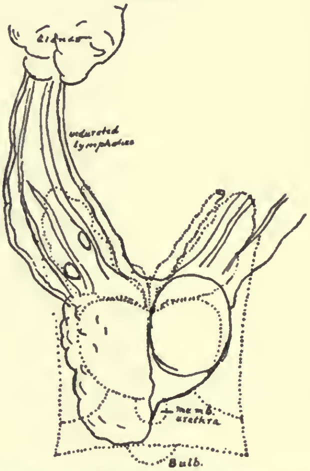
Fig. 2.



Cancer of prostate—seminal vesicles, intervesicular plateau. Indurated lymphatics.

Membranous Urethra.—The above tabulation also shows a considerable involvement of the membranous urethra, and here again the figures are probably less than the truth, because in many of the early cases the records are not complete in this respect. As shown here, however, there was more or less thickening of the membranous urethra in 32 cases, and in 61 cases distinct induration, often of stony hardness. In most of these cases the invasion was continuous with that of the prostate and simply surrounded the membranous urethra. In no cases was there any evidence of ulceration into the membranous urethra, which like the prostatic urethra very seldom becomes ulcerated in cases of carcinoma.

Fig. 3.



Showing marked involvement on one side in a case in which the only symptom was swelling of the right leg.

In a few cases the disease spread to the perineum from the membranous urethra, involving the fascia back of the triangular ligament on one (Fig. 3) or both sides,—this was recorded in 5 cases. In only 3 cases did the disease extend in front of the triangular ligament, and in these the corpus spongiosum had become infiltrated. In one interesting case the corpora cavernosa were apparently completely replaced by carcinomatous infiltration which extended up to the glans penis, thus producing a constant erection of almost complete character which was due entirely to the carcinoma. In this case, as well as the two mentioned above, there was no ulceration of the urethra and no hæmaturia.

Rectum.—As remarked above, the two layers of the aponeurosis of Denonvilliers act as a powerful barrier against backward invasion of carcinoma of the prostate, and this is abundantly proven by the fact that among these 111 cases only one in which the mucous membrane of the rectum was ulcerated was present. In 8 cases the rectal muscle was invaded and in 13 cases the prostate was adherent to the rectum. In many of the later cases, however, the adhesions were probably only of such inflammatory character as is often seen adjacent to malignant growths, and do not necessarily mean invasion. While the aponeurosis of Denonvilliers (Fig. 4) protects the rectum from invasion it does not prevent constriction of its lumen either by the bulk of the carcinomatous mass or by constriction in the region of the seminal vesicles through the development of a ring of carcinoma around the rectum. This was present in only a few cases when first examined; but from the letters I have received concerning of the progress of the disease, I am satisfied that it has occurred not infrequently later in the disease. In fact, it forms one of the most troublesome later complications, leading to partial or almost complete stricture of the rectum, severe obstipation and occasionally requiring colostomy.

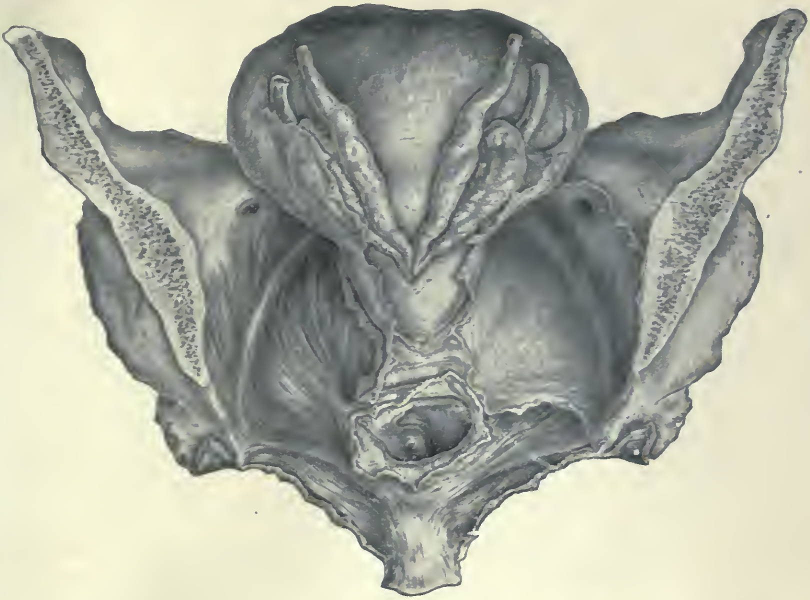
The Bladder.—The conditions present in the bladder have been studied in various ways: in 49 cases by cystoscopy; in 6 cases by suprapubic cystotomy; 21 cases by perineal prostatectomy, and 12 cases by autopsy. In not all cases were the notes full in every respect so that the figures in the tabulation given below are not always complete. They show, however, very forcibly the fact that intravesical tumor growth is extremely rare and only occurs very late in the disease, and then only in a small percentage of cases, that the trigone is often thickened and that the changes at the prostatic orifice consist usually in thickening or possibly slight rounding of the median portion. In those cases in which considerable enlargement of the lateral lobes was found, it was probably due in all cases to a coexistent adenomatous hypertrophy.

CONDITIONS WITHIN THE BLADDER.

	By cystoscopy.	Suprapubic op. examination.	Perineal op. examination.
Median portion:			
Normal	1	3	..
Slight bar	23	..	8
Considerable bar	15	1	6
Rounded lobe	5	2	3
Right lateral:			
Normal	16	3	..
Slight	26	2	17
Considerable	5	..	2
Left lateral:			
Normal	17	3	..
Slight	22	2	17
Considerable	7	..	2
Trigone:			
Negative	13	2	..
Thickened	17	3	8
Ulcerated	..	..	..
Tumor	..	..	..
Ureteral ridges:			
Negative	20	3	..
Elevated	15	1	..
Ulcerated	..	..	..
Tumor	2	..	..
Rest of bladder:			
Negative	21	4	16
Ulcerated	1	..	..
Tumor	1	1	..

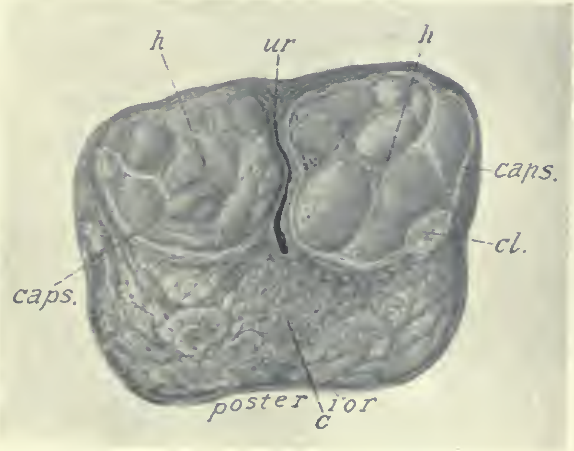
In explanation of this table it may be said that in many of the cases in which operation was not contemplated cystoscopic examination was not made, but I do not remember any of these cases in which the symptoms pointed at all to any vesical involvement of the bladder. Judging by the one case in which carcinomatous tumor, which had gone through from the seminal vesicles and formed a considerable growth in the region of the trigone, the symptoms would have been so urgent, had carcinoma been present in the bladder, that either a suprapubic cystotomy would have been performed, during which vesical involvement, tumor, etc., would have been

FIG. 4.



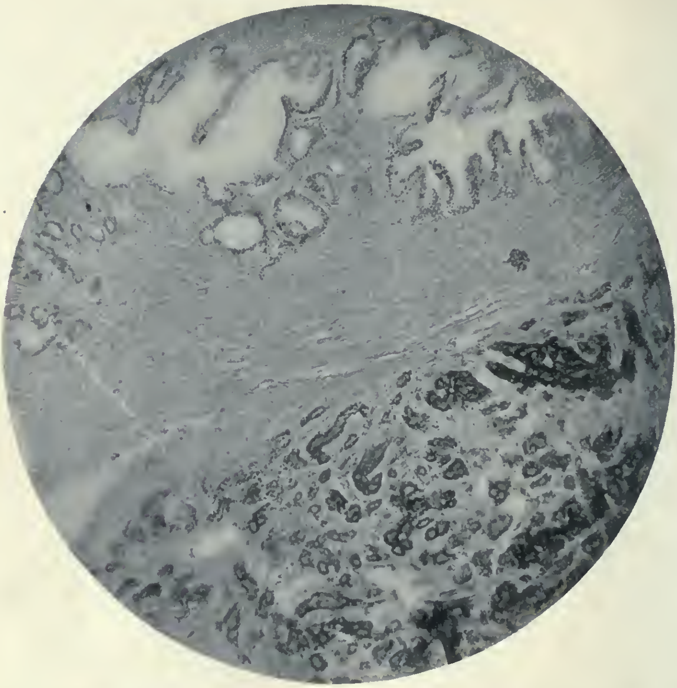
The aponeurosis of Denonvilliers, which covers the posterior surface of prostate, seminal vesicles and vasa deferentia; here partly removed to show these structures. (After Deaver.)

FIG. 5.



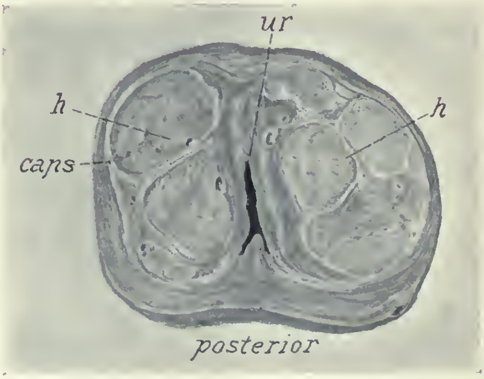
Transverse section in front of verumontanum, showing two large hypertrophied lobes on each side of the urethra and thick posterior subcapsular area of carcinoma. Capsule of right lateral lobe invaded in one place, *cl*.

FIG. 6



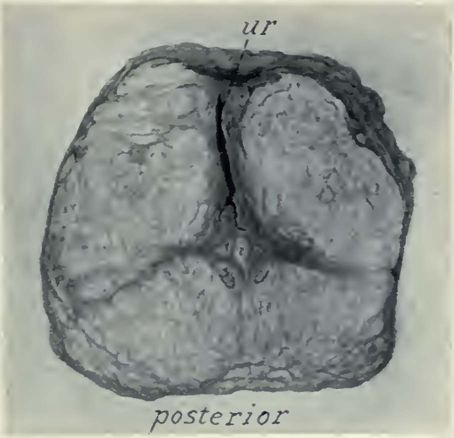
Showing the capsule surrounding an adenomatous hypertrophy (above) which has resisted extensive adenocarcinoma (below).

FIG. 7.



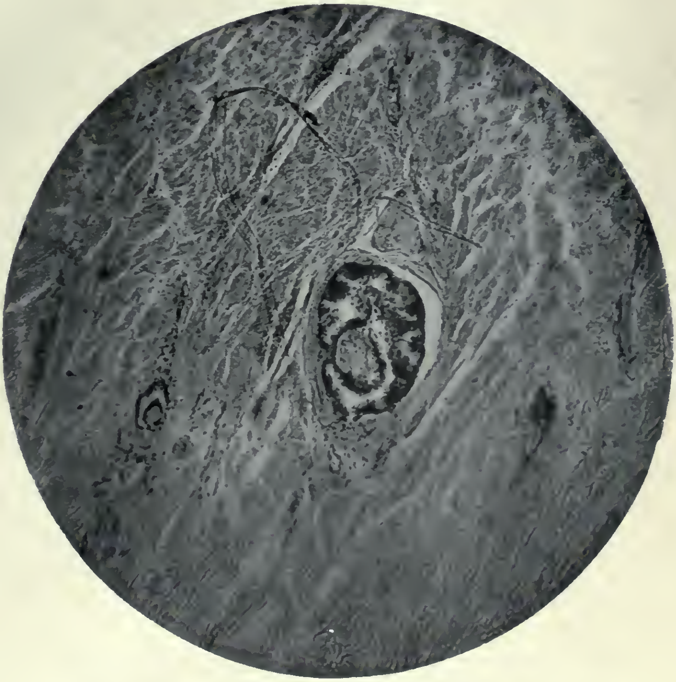
Transverse section in front of verumontanum in a case of benign hypertrophy of the lateral or central group of glands. Note the encapsulation of the hypertrophied mass and the transverse stratum of gland tissue between these and the posterior capsule.

Fig. 8.



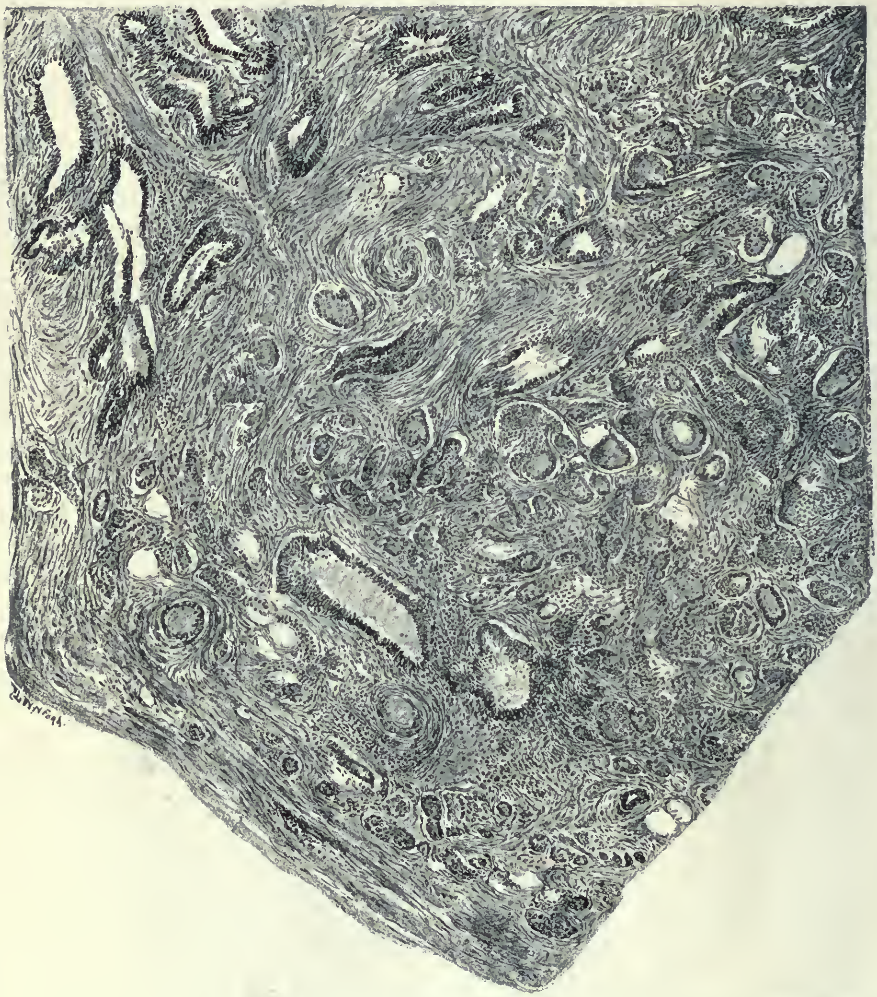
Transverse section just behind the verumontanum, showing complete invasion with carcinoma of both the central group and the posterior subcapsular stratum which is here greatly increased in thickness.

Fig. 10.



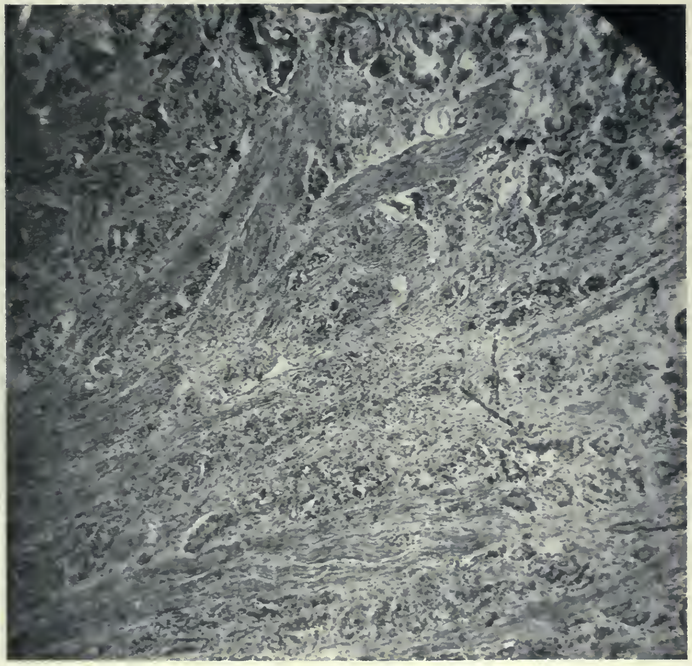
Showing carcinoma surrounding a nerve sheath which it has followed.

Fig. 9.



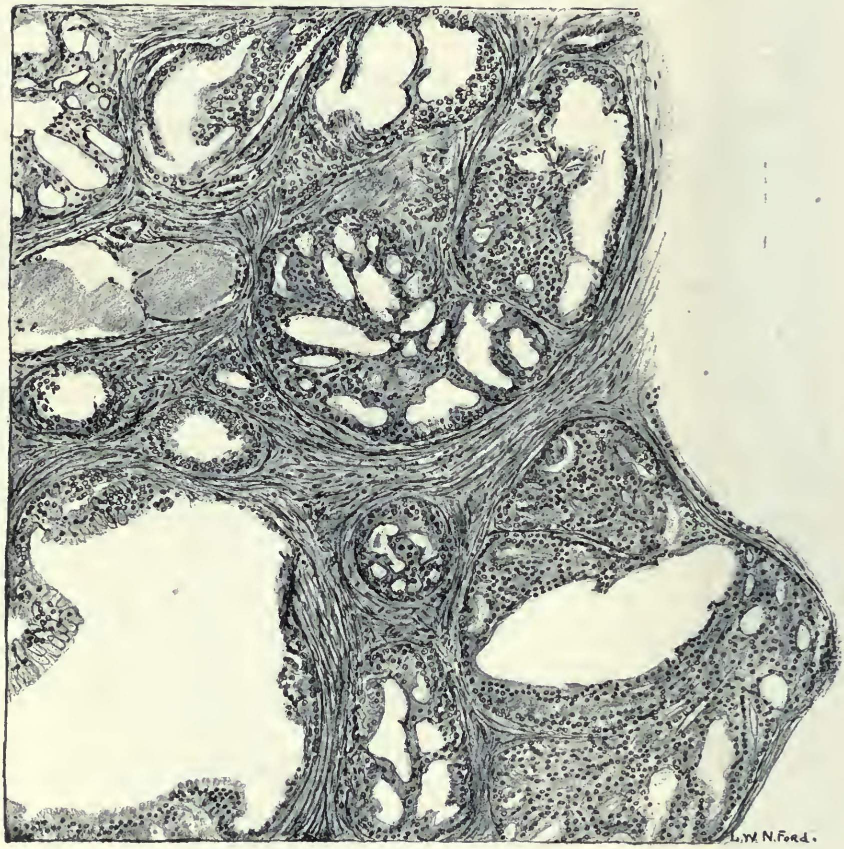
A small carcinoma nodule about 2 mm. in diameter in an otherwise benign prostate. Some of the normal acini still persist in the cancerous area.

FIG. 11.



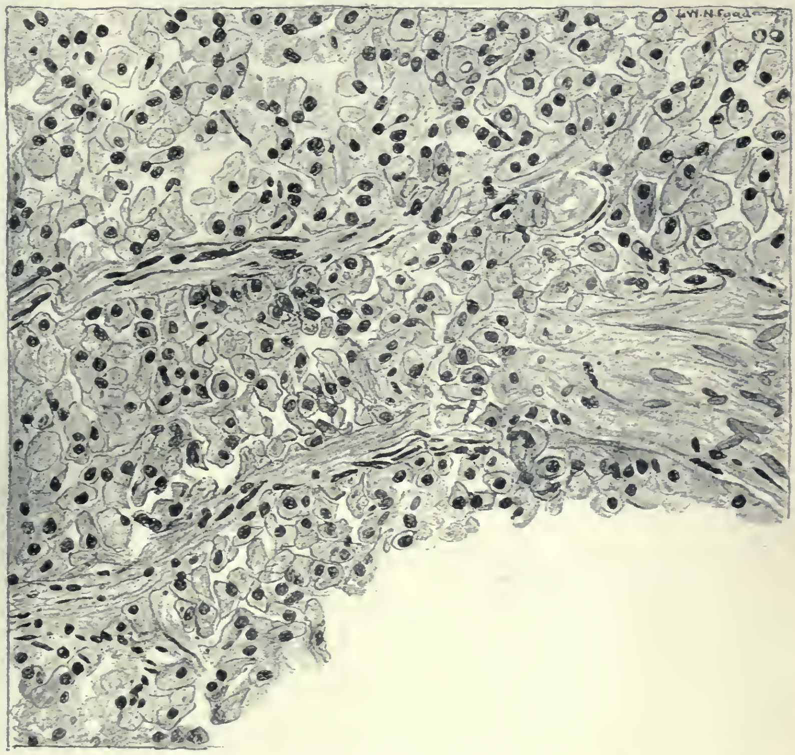
Scirrhous form of adenocarcinoma.

Fig. 12.



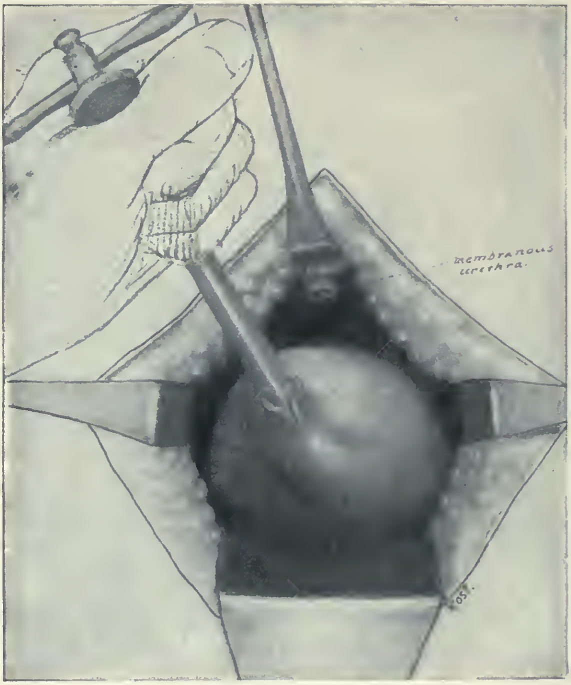
Showing spread of the carcinoma by way of the ducts. Solid strands of epithelial cells are seen growing into the lumina of the tubules and by their union forming irregular open spaces. There is no infiltration of the stroma.

FIG. 13.



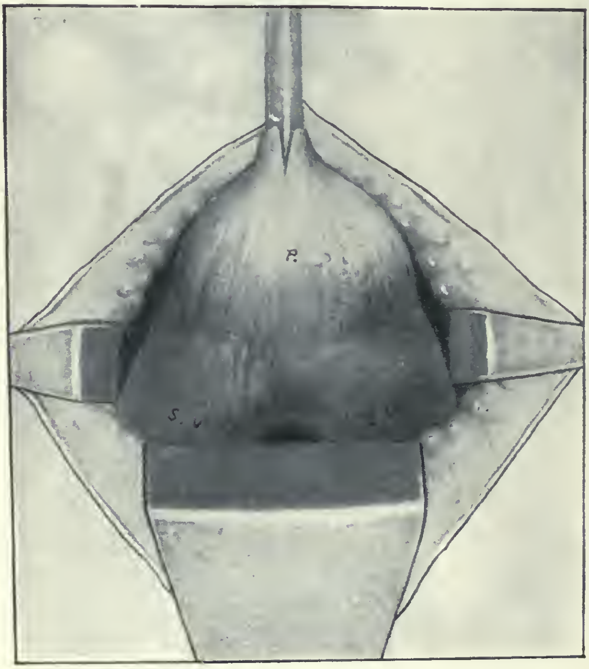
A medullary form of carcinoma in which there is very little stroma and the cancer cells varying in size and shape are loosely arranged.

FIG. 14



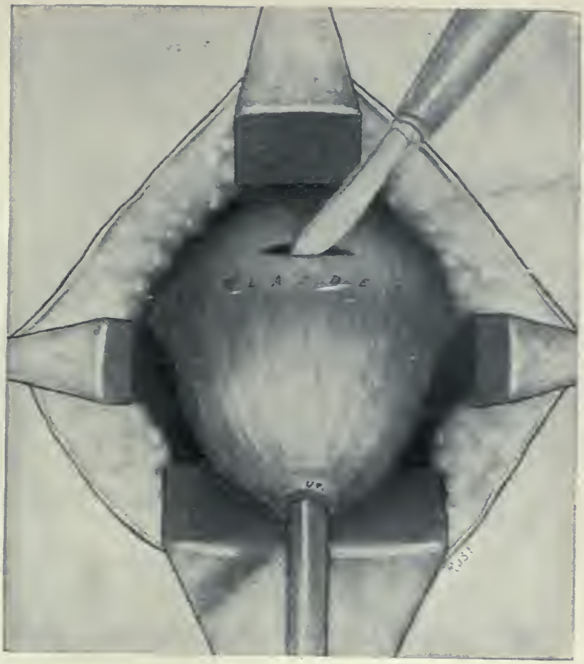
Transverse section of membranous urethra—anterior and posterior surfaces of prostate freed.

FIG. 15.



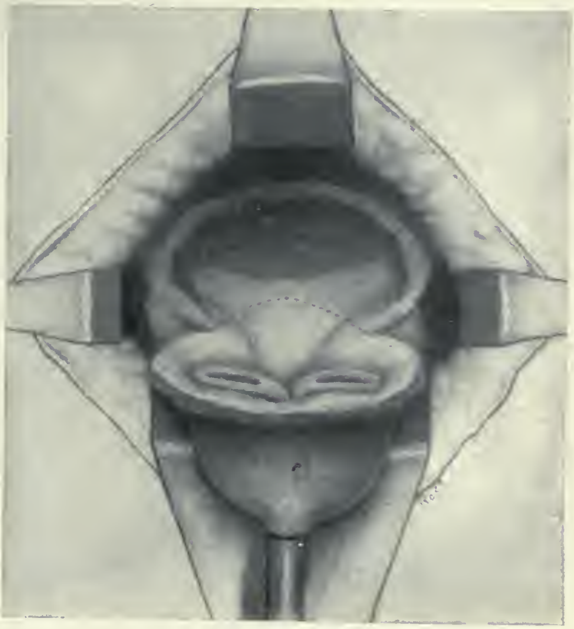
Exposure of seminal vesicles from behind.

FIG. 16.



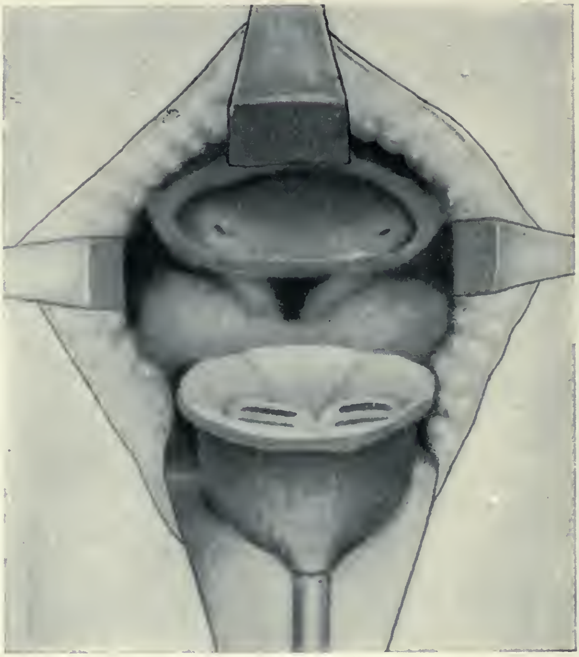
Incision into anterior wall of bladder just above prostate.

FIG. 17.



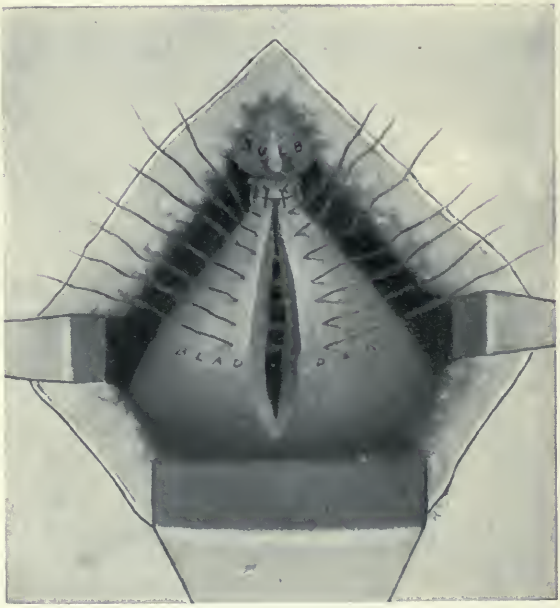
Exposure and division of trigone.

FIG. 18.



Final separation of seminal vesicles and vasa.

FIG. 19.



The anastomosis of anterior wall of bladder to urethra has been made. The rest of vesical opening is being closed.

demonstrated. In the 12 *autopsies* of which we have careful examinations there were only 2 in which the disease had spread into the bladder in the shape of a tumor or ulcer. In both of these cases suprapubic cystotomies had been performed several months before, and although the base of the bladder was found invaded there was no ulceration or any form of intravesical tumor. It must be remembered, however, that most of these examinations and operations were made several months before the death of the patient, and were not largely composed of autopsies of patients in most advanced stages of the disease, as in the statistics of Kaufman and Motz. It is therefore safe to say that carcinoma of the prostate "almost avoids" the bladder, and that when it does invade it it is only after the trigone has become invaded from disease anterior to the seminal vesicles and the intervesicular space. The conditions around the prostate orifice are also shown to be very characteristic in both cystoscopic, suprapubic and perineal examinations. As seen here, the median portion of the prostate is generally enlarged in the shape of a bar, most often of slight degree and without sulci on either side.* In about 30 per cent. of the cases the bar has been called considerable. It was in nearly every instance, however, much less than that seen in the considerable bar formations found in prostatic hypertrophy, and in all cases in which a rounded lobe was found in the median portion of the prostate the microscope showed it to be an adenomatous hypertrophy in all but one case. In this one a small globular median lobe was apparently purely carcinomatous. The median portion of the prostate was often not elevated above the trigone, owing to the fact that the trigone itself was elevated by a carcinomatous invasion of its anterior portion from beneath. In some cases this served to continue the prostatic bar backward two or more centimetres on the trigone. In a very few instances the entire trigone was thickened and elevated. Although the thickening of the trigone occurred in about 30 per cent. of the cases and was occasionally quite considerable, in no cases was the trigone ulcerated at the time of examination. The same thing was true as regards the prostatic orifice, for although the cancer not infrequently involved all the median and lateral portions up to the vesical mucous membrane itself, there was no ulceration present. The lateral lobes most often showed practically no change intravesically beyond the very slight rounding of the lateral margins. In only 5 cases were considerably enlarged lateral lobes seen with the cystoscope, and in only 2 cases in which the perineal prostatectomy was performed. In both of the latter cases the intravesical lateral lobes were composed entirely of benign adenomatous hypertrophy. As a result of our clinical studies we feel justified in saying that when no hypertrophy is present the enlargement of the prostate in cancer is generally slight; that the growth is almost invariably upward into the space between the seminal vesicles and around the vasa deferentia beneath the trigone; that the changes at the vesical orifice consist usually in a slight thickening of the median portion of the prostate with sclerotic condition of the internal sphincter (making a urethral orifice which is difficult to dilate) and that in some cases the median portion is in the shape of a moderately thickened bar, but never, except extremely rarely, a rounded intravesical lobe; that the trigone very frequently becomes thickened and sometimes considerably elevated from infiltration, but that the mucous membrane everywhere (bladder and urethra) preserves its integrity wonderfully; that it rarely becomes ulcerated and then only very late in the disease.

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* For an exhaustive study of "Cystoscopy in Diseases of the Prostate," see vol. xiii, Johns Hopkins Hospital Reports.

Stricture of the prostatic urethra was discovered in 8 cases, and probably existed in others. In only one case was it impermeable to filiforms and all other instruments. Most often it was merely a contracture through which small straight instruments (Nelaton catheters) could be passed, but impermeable to Coudé catheters and cystoscopes.

Suburethral Thickening.—It has only been within recent months that careful notes have been made as to the condition found between the cystoscope in the bladder and the index finger in the rectum, but during that time 32 cases in which definite thickening of the entire suburethral portion (posterior commissure of the prostate) was present, and in 25 of these cases the condition was said to be of very marked degree in this region. This condition, I believe, exists in almost all cases of carcinoma of the prostate with the exception of those very early forms in which only a very small portion of one of the lateral lobes is involved. This invasion of the posterior commissure of the prostate leads to considerable thickening and induration, and when examination is made with the finger in the rectum and cystoscope in the urethra it is often impossible to feel the instrument anywhere along the urethra and particularly in the region of the median portion. If the disease has progressed above the upper end of the prostate, thus forming an intervesicular plateau, it is usually impossible to feel the beak of the instrument in the bladder. This condition is entirely different from that found in benign hypertrophy, in which it is usually possible to palpate the shaft of the instrument through the posterior commissure (which is usually not much increased in size until the median portion of the prostate just beneath the vesical orifice is reached), and it is very rare to find even in the median portion a marked induration in benign hypertrophy, and the beak of the cystoscope can generally be felt through the bladder unless the enlargement of the median portion is considerable.

PATHOLOGY.

Pathological examinations have for the most part been made by Dr. John T. Geraghty, who is in charge of the museum of the genito-urinary specimens and the laboratory attached to it at the Johns Hopkins Hospital,—and these remarks are for the most part results of his study and analysis of the cases, and will appear later in a more comprehensive report which he is going to make on the subject.

The material comprises the following: Nine autopsies; 6

radical operations; 24 partial perineal prostatectomies. (This is 6 more perineal prostatectomies than are reported by me later on. They are either cases operated upon by others or very recent cases, too early to speak of the clinical results.)

An effort was made to decide certainly whether the disease of the prostate began as a carcinoma or whether there was previously a hypertrophy present which finally became carcinomatous.

Primary Cases.—In 12 cases it was definite that no hypertrophy had been present and that the carcinoma was primary. In 16 cases cancer and hypertrophy were present in the same prostate, but in different locations so that they were well demarcated. In 9 cases the entire prostate was carcinomatous, but it was impossible to say positively that portions of it did not represent lobules previously hypertrophied which had become carcinomatous. In the latter cases the prostate was much larger than the cases which were considered surely primary and the central portions of the prostate were more or less separated by bands of fibrous tissue suggesting the previous presence of adenomatous spheroids, but not with sufficient distinctness to say that they had been positively present. In the 12 primary cases the prostate was always small, in 6 about normal in size, in 6 very slightly enlarged. In half of the cases the whole prostate was involved, in the other half normal prostatic tissue was present in varying degrees. In the latter cases rectal examination showed, before operation, elasticity in the portion of the prostate which was not completely replaced by carcinoma. In no instance was cancer found involving the entire prostate in which a portion of one of the lobes was soft on rectal examination.

In the 6 cases in which the entire prostate was cancerous the seminal vesicles were involved. In one of the cases the invasion was proved by microscopic examination, in the other 5 cases the changes in the vesicles, revealed by rectal examination, was sufficiently conclusive to be diagnostic of carcinomatous involvement. In the 6 cases in which the whole prostate was not cancerous, both seminal vesicles were involved in

2 cases and one vesicle in one case. In 3 cases no invasion of the vesicles was present, and in 2 of these a careful microscopic examination of the vesicles removed by radical operation was made. In the third case no tissue of the seminal vesicles was obtained (the operation being conservative perineal prostectomy), but rectal examination before operation and now 17 months after the operation showed no induration of the seminal vesicles. In this case carcinoma was localized to a small portion of one lateral lobe and was apparently completely removed. In one case (radical operation, Case VI) in which the disease of the prostate was extensive, involving all the prostate except a small portion of the left lateral lobe and invading extensively the anterior commissure, no invasion of the seminal vesicles was present and no extensions were found in the lymphatics or vesical muscle adjacent to the prostate. The carcinoma had apparently not broken out of the confines of the prostate itself.

Coexistent Benign Hypertrophy and Cancer.—Of the 16 cases in which an adenomatous hypertrophy and carcinoma were present at the same time the posterior subcapsular portion was that which contained the cancer, while the central group of glands on each side of the urethra was that which contained the hypertrophy. This is beautifully shown in Fig. 5, taken from Case V, in which a radical operation was performed. This is a transverse section made just in front of the verumontanum, and shows the urethra flattened between the two well-encapsulated hypertrophied lateral lobes composed of numerous small and large spheroids. The cancer is confined to the portion of the prostate posterior to this and immediately beneath the posterior capsule, with the exception of one place where it has broken through the capsule of the left lateral lobe and invaded one of the spheroids (Fig. 5, *cl*). The microscopic view showing the capsule intact with hypertrophy above and cancer below is shown in Fig. 6. Perhaps it may be well to remark here that in benign hypertrophy of the lateral lobes of the prostate the picture presented is usually that shown in Fig. 7. As seen here the hypertrophied masses lie on each side of the urethra and are themselves surrounded by a capsule produced by peripheral condensation of normal tissues from pressure of the growing mass which anteriorly and laterally is in close apposition to the capsule of the prostate itself. Posteriorly, however, it is separated from the prostatic capsule by a transverse layer of gland tissue, as shown in Fig. 7. In some cases in which the hypertrophy of the lateral or central group of glands is not very extensive this posterior subcapsular stratum of gland tissue is quite thick (sometimes almost 1 cm.); but in others in which the lateral lobes are markedly hypertrophied this tissue is often quite thin (3 or 4 mm.), being evidently compressed by the pressure of the lateral lobes. In performing perineal prostatectomy one should always go in front of this posterior stratum in order to reach the proper layer cleavage for enucleation. This glandular stratum also remains after suprapubic prostatectomy, and should do so. In our statistics it has been found that carcinoma almost always begins in this posterior subcapsular stratum of the prostate. The only positive exception is a case mentioned in the text in which an area of cancer 1 cm. in diameter was found confined to the anterior commissure. Cancer beginning in this posterior subcapsular stratum leads to considerable increase in thickness of this suburethral portion of the prostate as shown in Figs. 5 and 8. In the latter figure, which is taken behind the verumontanum, and shows the ejaculatory ducts, although the whole prostate is carcinomatous, the lateral central portions and the posterior subcapsular stratum, which is shown considerably thickened, are still seen separated by a layer of fibrous tissue. This intermediate layer of fibres which is a normal structure (but markedly increased in hypertrophy) has never been sufficiently recognized before and its importance in determining the growth of carcinoma has never been mentioned to our knowledge.

In 13 of the 16 cases in which adenomatous hypertrophy was also present, the lateral lobes were free from cancer presented a typical appearance of benign hypertrophy surrounded by capsule which was everywhere intact. In one case (radical operation, Case I) although the whole prostate was completely carcinomatous, a definite lobulation similar to that seen in adenomatous hypertrophy was present in the lateral lobes, so that we feel sure that hypertrophy had once been present, although in this case the symptoms of urinary obstruction had only been present for eleven months.

Early Cases.—In one case an area, a few millimetres in diameter, was discovered on microscopic examination (see Fig. 9). The patient had been subjected to conservative perineal prostatectomy for considerable adenomatous hypertrophy and this area of carcinoma was discovered on pathologic and microscopic examination (Case XII, also Johns Hopkins Hospital Reports, vol. xiv, cancer, Case IX). It was not possible to absolutely locate the position in the prostate of this nodule. Most of the tissue removed at operation consisted of benign adenomatous spheroids; but the tissue around and in the vicinity of this nodule of cancer showed no evidence of adenomatous changes, but ordinarily prostatic tissue with well-marked periacinous inflammation, and it seems probable that it represented glandular tissue in the posterior subcapsular stratum which we have shown to be the favorite site of benign carcinoma and also the region which seldom becomes hypertrophied. In the third case a cancer nodule about 1 cm. in diameter was found in the anterior commissure as mentioned before. No hypertrophied tissue was present in the anterior commissure although the lateral and median lobes were the site of well-developed hypertrophy. The posterior subcapsular stratum was negative.

The 13 cases described above in which benign hypertrophied lobes although adjacent to a broad stratum of cancer posteriorly remained free from invasion showed very conclusively the remarkable defense which the capsule surrounding these hypertrophied masses offers to the invasion of cancer. In the case shown in Fig. 5 the disease had extended upward between the seminal vesicles and bladder, and involved the peritoneum and pelvic glands, but the hypertrophied lobes immediately adjacent to the original mass of cancer in the prostate showed only one place in which the capsule was invaded.

The Question of Malignant Degeneration, "Epithelioma Adenoid."—In over 300 specimens removed by prostatectomy we have not found, after careful examination, a single case in which there was an area of cancer in the middle of a hypertrophied lobe, lobule or spheroid, that is, there was no case in which cancer or cancerous "degeneration" was present in the interior of a hypertrophied lobe. Whenever a hypertrophied lobe showed cancer within its capsule it was always found infiltrating the lobe through the capsule from an area of much more extensive and evidently earlier carcinoma. We have never been able to discover any areas suggesting the "epithelioma adenoid" of Albarran which he thought was a malignant degeneration or development in tissue previously hypertrophied, and which he claimed was present in 14 per cent. of his cases which were clinically and macroscopically benign. The picture which he described we have frequently seen in chronic prostatitis and various forms of benign hypertrophy, and it is certainly not the same as is seen in definite carcinoma of the prostate. The fact that none of our cases of carcinoma show areas of malignant change in the middle of hypertrophied spheroids or lobules, the capsules of which are still intact, shows, we think, conclusively that the condition described by Albarran was not malignant in its nature and that it is not the method of development of prostatic carcinoma.

Invasion of the Seminal Vesicles.—In 5 cases the vesicles were not clinically involved. The remaining 11 cases all showed invasion of the testicles in varying degree, but always extensive.

In 5 of these 11 cases the spread of the disease to the vesicles was verified by microscopic examination. In 2 cases only one vesicle was involved. In one case, although the whole prostate was almost entirely cancerous, the disease had involved only the anterior portion of the vesicle wall. The posterior portion of the vesicles was entirely free of disease, so that the cancer mass really lay in front of the vesicles.

Except in the rather advanced cases the cavities of the vesicles were not invaded, the disease lying in the perivesicular tissue and infiltrating the walls. The most intense disease is almost always seen towards the inner side, around the vasa deferentia, and as a rule extends higher on this side than on the outer side of the vesicle. The wall of the vas resists invasion of its cavity for a long time and the structure of the vas is rarely entirely destroyed.

The place where cancer escapes from the confines of the prostate seems to be at the base about the entrance of the ejaculatory ducts. This portion, together with the portion of the prostate abutting on the lower end of the vesicles, is not reinforced in its capsule by the fascia of Denonvilliers, which passes from the posterior surface of the prostate to the seminal vesicles. In only three cases examined the disease had invaded the walls, but had not broken into the lumen of the ducts. In every instance in which the vesicles have been involved the process has been by direct extension from the upper limits of the prostate. In no cases, in which the malignant growth was entirely within the confines of the prostate, have lymphatic extensions been found along the seminal vesicles. The main lymphatic trunks run on the outer side of the seminal vesicles, and the process is usually most extensive on the inner side, around the vasa deferentia, and not infrequently the outer side is free of disease. This apparently accounts for the rarity of glandular metastases.

Invasion of Capsule.—With but three exceptions the disease had infiltrated the deeper portions of the capsule, but in no case, except one with stricture of the rectum, had it completely broken through the outer (posterior) layers of the capsule, the fascia of Denonvilliers. The nerves in the periphery often show cancer nests in the lymphatic spaces about them, sometimes well beyond the main cancer mass (see Fig. 10).

Bladder Invasion.—In only two specimens (both obtained at autopsy) had the growth invaded the bladder to form a vesical tumor. In both the disease was far advanced and death was a direct result of the malignant growth. The tumor invasion in each case occupied the whole posterior wall of the bladder and was a direct infiltration posteriorly from the seminal vesicles. The vesical tumor consisted of small rounded nodular tumor masses with comparatively smooth surfaces. The vesical orifice was not the site of the tumor formation in a single case, thus showing that cancer of the prostate does not invade the bladder in this region (or at most excessively rarely).

The great rarity also of vesical ulceration and tumor formation from prostatic carcinoma in our statistics is also at variance with the findings of Motz. The fact that carcinoma of the prostate is infiltrative and not ulcerative in character is shown by the fact that in none of our operations or autopsies have we found a single case of ulceration of the urethra or of the rectum, and all of these facts go to show that Motz's statistics, based largely on autopsies of patients dying late in the disease, and therefore with the most extensive possible lesions, do not give a true clinical picture of carcinoma of the prostate. In our experience, it is certainly not true that many cases of vesical tumor are due to carcinoma springing from the prostate of seminal vesicles,—in fact, it seems very rare that such occurs.

In concluding this note on the gross pathology we feel justified in stating, first, that carcinoma of the prostate does not result as a degeneration of the previously benign adenomatous process; that in about half of the cases it develops where no hypertrophy is present; that in such cases the prostate is often little if at all enlarged; that the carcinomatous growth follows planes of least resistance; that it is very slow in invading fibrous capsules, both of the prostate itself and also of hypertrophied spheroids, lobules or lobes; that the mucosa and submucosa of both urethra and bladder are also very resistent to it; that the most common site for the beginning of cancer is in the posterior subcapsular stratum and that from there it may invade the rest of the prostatic glandular tissue or it may travel upward, escaping from the upper end of the prostate in the region about the ejaculatory ducts and between the fascia of Denonvilliers posteriorly and the trigone anteriorly; that in its further growth the seminal vesicles and vasa deferentia may not become infiltrated, but in some cases their lumina may become filled with cancer cells and, in the case of the vasa deferentia, these may extend upward for a long distance, the outer walls of the vas remaining apparently intact; that the muscle of trigone and bladder and also the peritoneum may be invaded from this subtrigonal involvement; and, finally, that the fascia of Denonvilliers, which gives the prostate its most dense capsule posteriorly, is a most effective agent in preventing involvement of the rectum and periprostatic structures.

HISTOLOGY.

Perhaps we can make our description of cancer clearer if we first give our impression of the microscopic appearance of the normal prostate and in benign hypertrophy.

The tissue of the normal prostate is rather grayish in color and somewhat moist. It is soft in consistency but tough. On pressure a small amount of prostatic secretion can frequently be squeezed out. The cut surface is apparently smooth and homogeneous, but on close inspection the tiny glandular orifices can be discovered. Sometimes the orifices of dilated acini are very evident.

The tissue of benign prostatic adenoma is usually quite characteristic. It has a lobular appearance due to the formation of varying sized spheroidal tumors often definitely encapsulated, the lobular mass as a whole being compressed by a more or less well-developed capsule formed from the condensed peripheral prostatic tissue. The tissue is usually elastic or soft in consistence and on section is moist. Frequently large quantities of a milky fluid ooze from the prostatic acini. Many of the lobules have a moth-eaten appearance due to the presence of dilated acini. In other lobules where the glandular elements are not so numerous and the stroma predominates the surface is rather smooth and slimy.

Practically no difficulty is encountered in differentiating carcinomatous prostatic tissue from the tissue of hypertrophy or of the normal prostate, presupposing of course that the carcinomatous area is of sufficient size to be discernible. The greatest difficulty arises in distinguishing from the tissue of a long-standing fibroid prostatitis. Carcinoma is usually quite characteristic. It is hard, dense and on pressure gives very little sense of elasticity (which is generally not lost even in well-advanced fibroid prostatitis). On cutting into the carcinoma it imparts a gritty sensation to the knife blade. No secretion oozes from the cut surface, which is rather homogeneous, lacking the lobulation so characteristic of hypertrophy. Occasionally where the cancer has invaded a previously benign adenoma an indefinite lobulation may persist in this tissue, but it is seldom confusing.

The finer details of the cut surface vary. Sometimes irregularly interlacing translucent bands of varying sizes, are seen with small grayish yellow islands scattered here and there, the translucent bands being fibrous in character and the yellowish areas accumulations of cancer cells. This appearance is not present in fibroid prostatitis, in which the epithelial elements practically disappear and the surface is much more smooth and homogeneous than in cancer. Where the cancer is infiltrating in character, fine alternating translucent and yellowish lines can frequently be seen by the aid of a small magnifying lens. Usually one can be moderately certain of the cancerous nature of the tissue from gross inspection alone. When the operator's knife, in making his capsular incisions, cuts through dense tissue which does not bulge, the edges of which are firm and rigid, suspicion should be at once aroused.

If, after passing through such a layer of hard tissue, a bulging hypertrophied lobe is encountered, the diagnosis of coexistent cancer and hypertrophy is generally justified. The capsule of the average hypertrophy is rarely thick, nor is it so dense and gritty as that of cancer.

Microscopic.—The histologic character of cancer of the prostate is very variable, being greatly modified by the character of tissue invaded and age of cancer and the method of extension.

A classification according to type of cell, is as a rule impossible, as no one type is preserved throughout, the same section often showing great varieties of shapes and sizes. In the two cases in which cancer areas a few millimetres in diameter were discovered the growth was a definite adenocarcinoma, but in one of these, even at this early stage, marked infiltration into the stroma had begun.

In our apparently primary cases the cancer more often tended towards the scirrhous type, 7 of over 10 cases being of this type (Fig. 11). In 3 cases no glandular formation was present; in the other 4 cases occasional small groups of atypical acini were seen, but the great bulk of the tissue was scirrhous. At times the fibrous overgrowth is so marked that epithelial elements may be almost wanting, or the fibrous stroma is so dense that the cancer cells are often not recognizable, small nuclear specks being alone visible. This may lead to error of diagnosis if only a small section is examined, as in Case VI, radical operation. At other times definite masses or infiltrating lines of irregular shaped cancer cells are seen, the size and shape seeming to depend largely upon the compressing force of the fibrous stroma.

Those of the adenocarcinomatous type present most varying pictures. At times acini, formed of irregular cells (sometimes small, sometimes large), often with big deep staining nuclei, are scattered at wide intervals, the intervening tissue being more or less densely infiltrated with cancer cells. At other times the cancer acini are so numerous and close together that fibrous stroma may be difficult to see. The acini in these areas are usually very small and lined by small cylindrical cells often quite irregular in shape and with small rounded nuclei. Often over large areas no attempt at a glandular reproduction occurs, cancer cells simply growing aimlessly through a fibrous stroma. Occasionally normal acini are found persisting in large areas of cancer.

Cancer of the prostate spreads in two ways, by direct extension through the stroma and by extension along the ducts. As a result of this duct extension one sometimes sees masses of cancer cells filling the acini, the intervening tissue being entirely normal.

Cancer Associated with Hypertrophy.—In our cases in which cancer and hypertrophy were present together the cancer, as remarked before, generally forms a layer beneath the posterior capsule, and the hypertrophied lateral lobes lie in front of and distinctly separated from the cancer by their own capsules which are generally intact (Fig. 5). When the cancer breaks into a hypertrophied adenomatous lobule it spreads rapidly along the ducts, thus giving an extremely puzzling picture (Fig. 12). Glandular acini lined or filled with cells different in type from the cells of the ducts or acini of an adenomatous hypertrophy, but with a basement membrane often intact and a normal intervening stroma. It would seem that the cancer cells, on breaking into the dilated, often cystic acini, of the adenomatous tissue, are relieved from the pressure of the stroma and the close packing of other cancer cells, and thus become larger in size. Their protoplasm is pale and stains with difficulty, while the nuclei become remarkably regular in size and staining properties. Frequently a single layer of these cells will reline a duct or acinus so that except for the character of the cell the acinus looks entirely benign. However, we have never seen these broad cylindrical cells with clear pale staining protoplasm and nuclei centrally placed either in the normal or the hypertrophied prostate. In other acini the cells are heaped up at different points along the gland wall and grow across the lumina sometimes in solid masses, but more frequently as interlacing strands (Fig. 12). Sometimes the cancer cells arrange themselves circularly, leaving a central lumen (Fig. 12) as if in an attempt to reproduce a gland structure. When the lumen is completely filled the cells crowd each other into most odd and peculiar shapes.

These areas of duct carcinoma are not apt to be mistaken for benign tissue if the character of the cells is noted. Particularly characteristic is the tendency of cancer cells to grow in strands across the lumen of the acinus without any supporting connective tissue framework. This does not occur in hypertrophy. In the latter when an epithelial budding from the wall of the acinus occurs, it is quickly followed by a supporting stem of connective tissue. It has been said that the acini of the normal or hypertrophied prostate when filled with desquamated epithelial cells may be difficult to differentiate from cancer of the duct type. With exercise of ordinary care no confusion from this source should occur. Later, with the advance of the main growth through the stroma or the breaking through from the acini, the picture is changed. Tubules of cancer cells with a more or less densely infiltrated stroma are seen, sometimes the intervening tissue is scirrhus, sometimes of an adenomatous type and sometimes the cancer cells are so closely packed that a fibrous stroma seems almost entirely absent and a medullary form of cancer is produced. Sometimes portions of the cancer seem more or less definitely alveolar. When the cancer invades hypertrophied lobes of the adenocystic type, in which interacinus stroma is frequently small in amount, the picture presented is that of cancer cells packed in the dilated spaces, resulting in an alveolar form of carcinoma medullary in character (Fig. 13). In none of our specimens, either primary or those associated with hypertrophy, was a pure adenocarcinomatous type preserved throughout. Areas of adenocarcinoma were present, however, in great or less degree, in practically every case except in the three cases of pure scirrhus previously mentioned, in which the cancer occurred in a prostate not previously hypertrophied.

In no case have we found evidence of gross or microscopic necrosis, no matter how extensive the disease. The extensions of the disease to the seminal vesicles and bladder wall are usually infiltrating in character, although frequently the adeno form is here and there discovered. For one familiar with the histologic character of the normal and hypertrophied prostate, the microscopic diagnosis of cancer seldom entails any difficulty, except in the scirrhus, where, occasionally, over small areas, the fibrous overgrowth may be so intense that no definite epithelial elements are recognizable, small scattered nuclear specks being alone visible. However, this fibrous density is of itself suspicious, and a section from a different area will usually at once settle this doubt.

OPERATIVE TREATMENT.

In order to determine the results which may be obtained by operations in cases of carcinoma of the prostate we have made a careful study of the results obtained by the various methods.

These comprise the following:

1. *Radical operation,* six cases.
2. *Conservative (partial) perineal prostatectomy,* nineteen cases.
3. *Suprapubic prostatectomy,* two cases.
4. *Bottini electrocautery operation,* seven cases.
5. *Perineal drainage,* two cases.

We have also made a study of cases in which no operation was performed, and these comprise:

6. *Cases treated by catheterization,* thirty-nine cases.
7. *Cases in which no catheter was advised,* twenty-nine cases.

In order to furnish a complete knowledge of the excellent results which have been obtained by the operation for radical excision, and also the surprisingly lasting results which have been obtained in extensive cases by conservative partial perineal prostatectomy, I have described the operative technic, the cases and the results in detail.

*Technic of the Radical Operation.**—The patient is placed in the exaggerated lithotomy position, and an inverted V perineal incision made, as in the operation for simple hypertrophy of the prostate, the successive steps of which are followed until the tractor has been inserted through a urethrotomy wound of the membranous urethra and the posterior surface of the prostate has been exposed, largely by blunt dissection. If there is then any doubt in the mind of the operator as to the malignant nature of the disease, an incision is made through the capsule and a section of the prostatic lobe removed for examination, frozen sections being made if necessary to establish the diagnosis, when either the simple prostatectomy for hypertrophy or the radical operation for cancer can be performed as the case requires. In the case of cancer the next step after exposing the posterior surface of the prostate is to free the lateral adhesions of the prostate and also the seminal vesicles as much as possible by blunt dissection; then the membranous urethra is divided in front of the tractor, as shown in Fig. 14. The handle of the tractor is then depressed markedly and the puboprostatic ligaments divided with scissors close up to the anterior surface of the prostate, efforts being previously made to push away the anterior plexus of veins by blunt dissection. Fairly abundant hemorrhage usually follows, and should be controlled as much as possible by clamps and then by a gauze pack, which should be held tightly against the posterior surface of the pubes and the triangular ligament by means of a retractor. The seminal vesicles should be freed further (Fig. 15).

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* Described first in the Johns Hopkins Hospital Bulletin, October, 1905.

The prostate is drawn outward as far as possible, thus exposing the anterior surface of the bladder, which should be punctured, as shown in Fig. 16, just above the prostatovesical juncture. This wound is now enlarged on each side by scissors, the line of division being close to the prostatovesical juncture, until the trigone is exposed, as shown in Fig. 17. With a scalpel a curved incision is made across the trigone, thus leaving the upper angles of the trigone intact, and being careful to do no injury to the ureters. By blunt dissection the seminal vesicles are then exposed, as shown in Fig. 18, and the vasa deferentia picked up with a blunt hook and divided with scissors as high up as possible. (In doing this it should be remembered that the vasa deferentia pass around the lower end of the ureters.) The deeper attachments of the seminal vesicles are then freed and the mass, consisting of the prostate, urethra, cuff of the bladder, seminal vesicles, and about 5 cm. of the vasa deferentia, removed in one piece. Hemorrhage is again encountered in the last step above described, owing to the fact that the prostatic plexus of veins, which passes up along each side of the prostate, is closely attached to the lateral border of the seminal vesicle; but this can easily be controlled by ligatures or long clamps. The bleeding which comes from the vesical wound is easily controlled by the subsequent sutures, which are placed so as to anastomose the bladder with the membranous urethra, and completely close the vesical wound. This is easily accomplished, as shown in Figs. 19 and 20. As seen here, the anterior wall of the bladder is drawn down and fastened to the stump of the membranous urethra by means of interrupted catgut sutures. After forming the anastomosis with the urethra a considerable vesical wound is left poster-

FIG. 20.

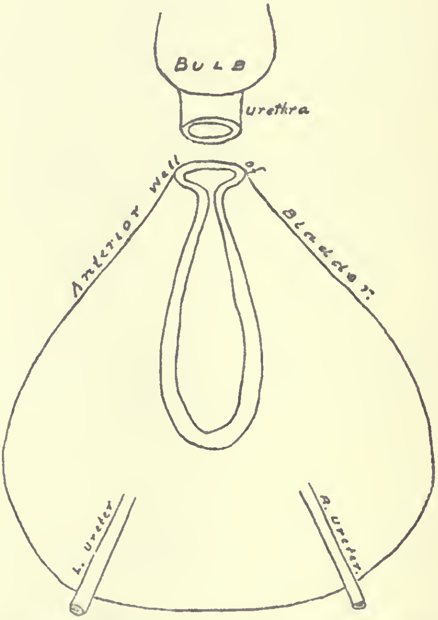


Diagram showing plan of vesico-urethral anastomosis.

iorly, but it is easily closed by transverse sutures. I have found it best to use an occasional suture of silkworm gut in order to take care of the tension which is present. The ends of these are left long enough to emerge from the wound, so that they can be removed two or three weeks later. A retained rubber catheter, which should be inserted before the vesico-urethral anastomosis is made, is fastened to the glans penis with adhesive plaster. After placing light gauze packing in the depths of the wound the levator ani muscles are approximated with two or three interrupted sutures of catgut, so as to protect the rectum against postoperative necrosis, and the external wound is almost completely closed with interrupted sutures of catgut. In some instances I found it difficult to place ligatures around hæmostatic clamps which were deeply placed, and have therefore not removed the clamps, but allowed them to emerge with the gauze packing from the anterior angle of the wound (they were removed 24 hours later). If careful attention has been given to the prevention of hemorrhage and an infusion has been begun early in the operation, there should be little or no shock.

CASE I.—*Carcinoma of prostate. Radical operation. Excision of entire prostate, seminal vesicles, ampullæ of vasa deferentia and cuff of bladder. Recovery. Lived nine months. Died of perivesicular infection following litholapaxy.*

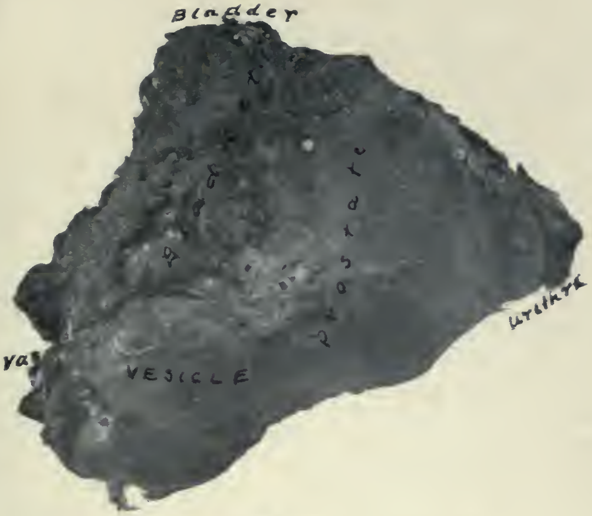
E. J. G., S. No. 15929. Aged 70; married. Admitted April 1, 1904. Eleven months ago patient began to have pain in the urethra at the end of urination. During the next three months the pains increased and he began treatment with an osteopath, receiving prostatic massage. He grew steadily worse and soon began to have pain in the perineum and thighs. Four months ago consulted a surgeon who performed a Bottini operation with partial benefit. He now has to void every fifteen minutes and severe pain is constantly present. On rectal examination the prostate is considerably enlarged, irregular, nodular, hard, and the capsule is apparently adherent to the rectum. The right seminal vesicle is palpable, apparently distended but not indurated. In the region of the left seminal vesicle there is an oblong mass of induration continuous with the prostate, but the upper end of the seminal vesicle seems free. Catheterization is very difficult, filiforms being required. Residual urine 400 c.c. The cystoscope shows no intravesical enlargement of the lateral lobes and only slight elevation of the median portion of the prostate. Diagnosis of carcinoma was made on marked induration of the prostate extending into the region of the left seminal vesicle and the absence of intravesical enlargement. After preliminary treatment (catheter, hydrotherapy, etc.), the radical operation was performed. Specimen removed is shown in Figs. 21 and 22.

As shown here, the seminal vesicles, intravesical and subtrigonal tissues were removed in one piece with the prostate and membranous urethra. No difficulty was experienced. There was only a moderate amount of hemorrhage and the anastomosis between bladder and membranous urethra was easily performed, silk sutures being used (a mistake to do so). A large rubber catheter was fastened in the urethra and patient returned to ward in good condition. The specimen (which along with the operation and microscopic examination is described in full in the Johns Hopkins Hospital Reports, vol. xiv, p. 506) showed adenocarcinoma of the entire prostate, which had extended into the tissues beneath the anterior portion of the trigone adjacent to the ejaculatory ducts and seminal vesicles, but had not penetrated into their cavities. In the muscle of the anterior part of the trigone several lymphatics containing cancer cells were seen, but at the upper limit the tissues seemed healthy everywhere.

The convalescence was satisfactory but slow. In two weeks the patient was walking about and all the stitches had been removed (apparently). Only a little urine came through the perineum. On the sixteenth day the perineal fistula was healed completely and urine came freely through the penis. On the twenty-third day the patient was discharged from the hospital in good condition. At night he could hold his urine for several hours until the desire to urinate came on, when he arose and voided. Did not wet the bed at night. During the day urine dribbled away.

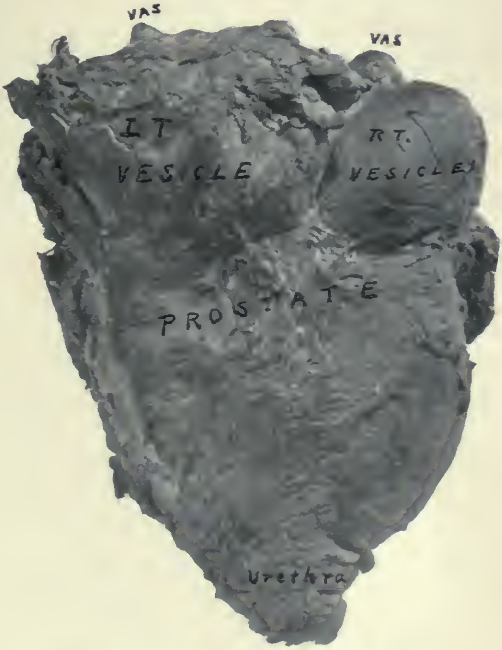
December 22: Patient improved steadily for five months, the intervals between urinations becoming long and incontinence gradually diminishing. In October he began to suffer pain at the end of the penis during urination. He has now incontinence

FIG. 21.



Photograph of specimen. Case I. Side view.

FIG. 22.



Photograph of specimen. Case I. Posterior view.

during the day, but none at night. A silver catheter meets an obstruction about the triangular ligament, but filiforms pass with ease and dilating followers are easily introduced. A stone is felt in the bladder and the cystoscope shows two small calculi in a shallow pouch on the right side of the bladder and, just behind the triangular ligament, a small stone attached to a silk suture which was easily seen.

December 23: *Operation. Litholapaxy.*—Two stones in the bladder were easily crushed and were evacuated, but to engage the calculus which was attached to the ligature it was found ncessary to pass through the urethra a long curved clamp with which the ligature was withdrawn; but in so doing a tear was made in the mucous membrane. Following the operation there was tenderness in the suprapubic region and an extensive perivesical infection developed from which the patient died one month after the operation.

Autopsy showed the bladder contracted, but excellent union between it and the urethra. There was no evidence of recurrence in the bladder or region of the prostate, and no glandular metastases were to be made out; but just back of the bladder a small indurated area, about 1 cm. in size, was present, and a section of this showed carcinoma. There was present a large perivesicular abscess cavity.

Note: This case showed the necessity of using some other form of suture material than silk, and for the next case catgut alone was employed (also to my regret). It was interesting to note that although the specimen showed after the operation that the prognosis was not good because the lymphatics above the prostate were involved, at autopsy, almost ten months after the radical operation, only a very small area of carcinoma was present (about 1 cm. in diameter and in the tissues back of the bladder which was healthy), and the patient had been entirely relieved of the severe pain and the obstruction to urination.

CASE II.—*Carcinoma of the prostate involving the lower portion of the seminal vesicles. Radical operation. Death six weeks later—nephritis. Autopsy showed no remaining carcinoma.*

W. R., S. No. 16675. Aged 64; married. Admitted September 14, 1904. Onset with increased frequency of urination three years ago. Complete retention of urine for the first time three weeks ago. On admission patient voided ten to twelve times during the day; no pain present. Complete retention of urine for the first time one week ago. No history of hæmaturia. Has lost very little in weight. For the past week catheterization has been necessary.

Rectal: The prostate is moderately enlarged, smooth, hard, but not nodular. There is no enlargement or induration in the region of either seminal vesicle, but in the space between the two there is a distinct plateau of induration extending between 1 and 2 cm. above the limits of the prostate. Above this the tissues feel soft. No glands. Rectum negative.

Cystoscopic: A catheter passes easily. Bladder capacity 300 c.c. The cystoscope shows a slight intravesical enlargement of the median portion which is continuous with an elevation of the anterior part of the trigone. Lateral lobes very slightly enlarged. Mucosa normal. With finger in rectum and cystoscope in urethra there is induration beneath the trigone and considerable thickening of the suburethral portion of the prostate. The diagnosis of carcinoma was made upon induration, suburethral thickening and the absence of intravesical hypertrophy.

September 23: Total excision of prostate, seminal vesicles, 5 cm. of the vasa deferentia, most of the trigone. When the trigone was exposed palpation showed an indurated condition of the trigone which seemed to extend up to the two urethral orifices. It was thought advisable to excise both ureteral papilla and a portion of the posterior wall of the bladder immediately above the trigone. The upper part of the intramural portion of the ureter on both sides was left undisturbed. The anastomosis between the bladder and membranous urethra was easily performed, care being taken not to include the partially excised ureters in the suture.

Examination of the specimen showed that the seminal vesicles and upper portions of the vasa deferentia were normal, and that the trigone, which seemed indurated, contained no carcinoma (Johns Hopkins Hospital Reports, vol. xiv, p. 511), and that it was unnecessary to excise the ureteral papillæ. Catgut was alone used as a suture material.

Convalescence: Patient convalesced poorly, nausea considerable. The wound broke down completely, leaving a large unhealthy cavity. At the end of three weeks he began to fail gradually, and died on November 8, forty-six days after the operation.

Autopsy.—Anatomical diagnosis—Perineal wound diphtheritic and hemorrhage, cystitis, ureteritis and pyelitis. Chronic diffuse nephritis, cardiac hypertrophy and dilatation. Chronic myocarditis, endocarditis and emphysema of the lungs. Chronic perihepatitis, splenitis and pancreatitis. The anterior wall of the bladder was found to be continuous with the urethra, sutured portion in this region having united. The posterior sutures had broken down. The right ureteral orifice was covered by a small calcareous mass. The left ureteral orifice could not be found. Acute urethritis was present on both sides, evidently an ascending infection. Careful examination failed to reveal carcinoma anywhere in the pelvic tissues or in other portions of the bladder. Numerous microscopic sections were made and showed no evidence of carcinoma.

Note: From the careful study of the specimen removed at operation and the autopsy it is evident that the malignant disease had been completely removed. The excision of the upper portion of the trigone and lower ends of the ureters was not necessary and probably led to the ascending renal infection which caused the death of the patient. The use of catgut proved a mistake, as it led to a rapid breaking down of the wound. The prognosis for a radical cure in this case should have been excellent.

CASE III.—*Cancer of the prostate involving the seminal vesicles and anterior part of the trigone. Radical operation. Recovery. Restoration of urination through urethra. Patient apparently well for nearly three years. Died over three years after the operation. Autopsy showed recurrence.*

S. R. B., Of. No. 829. Aged 65; widowed. Admitted February 4, 1905. Onset four years ago with increased frequency of urination, which has gradually increased until he now voids every few minutes. Never hæmaturia nor complete retention of urine. For two years pain in the left hip and knee. Constant pain in the back, perineum and rectum. No loss of weight.

Rectal: The prostate is considerably enlarged, smooth, very hard. In the upper end on each side is an indurated mass occupying the area of the seminal vesicle and between the two is a small indurated plateau. It is apparently easy to reach above the area of induration everywhere. The rectum is negative. No enlarged glands.

Cystoscopic: Residual urine 500 c.c. Moderate median bar, slight lateral enlargement. No clefts. No evidence of involvement of the trigone. Vesical mucosa normal. With finger in rectum and cystoscope in urethra considerable subtrigonal and suburethral thickening felt.

The diagnosis of carcinoma was made on the great hardness, involvement of the seminal vesicles, absence of intravesical prostatic outgrowths and pain.

February 16: Radical operation. The lower end of the left ureter was unintentionally removed with the specimen and it was found loose in the space behind the bladder. This accident was due to the use of straight scissors instead of curved ones while dividing the wall of the bladder, the incision going up much too high on the left side. The incision across the trigone was made with a knife and the lower end of the right ureter was spared. The divided left ureter was transplanted into a higher portion of the bladder by simply pushing a sharp clamp through from the inside and drawing the ureter into the bladder where it was held by two intravesical catgut and one extravesical silk suture. The bladder was easily drawn down and anastomosed with the stump of the urethra and the rest of the wound closed with alternate catgut and silkworm catgut sutures, one end of each of the latter sutures being left long so as to project from the wound to facilitate subsequent removal.

Examination of the specimen showed that the left ureteral ridge and 1.5 cm. of the lower end of the left ureter had been removed with the trigone, prostate, prostatic urethra, seminal vesicles and 4 cm. of the vasa deferentia in one piece. Sections of the upper portion of both seminal vesicles were negative for carcinoma, but the vasa deferentia were filled with cancer cells near the upper limit, and although the bladder muscle was negative the fat immediately beneath it showed small cancer cells. Microscopically the specimen is adenocarcinoma, in places carcinoma solidum.

The convalescence was satisfactory with the exception of a severe pressure slough on the back, due to a hard sand-bag at operation. The perineal wound healed in about two months. During the day there was incontinence, but at night he was able to retain 450 c.c. of urine and arise and void without wetting the bed. No stricture present.

March 12, 1906—Letter: "It is now thirteen months since operation. I now weigh 167 pounds, appetite and digestion good. Fistula is healed. Urine passes through penis, but I have no control during the day.'

April 15, 1908—Letter from son: "Father died March 29. For some time he has had symptoms of interstitial nephritis. He never did have any positive symptoms of recurrence. His bladder never troubled him at all other than from a little catarrhal condition. He complained greatly of pain in the sacral region, chest, shoulders and legs.

"Autopsy showed the bladder studded with many hard nodules and much thickened. Both kidneys were filled with pus. The retroperitoneal and bronchial glands, both kidneys and ureters showed metastases. Liver, spleen, stomach and intestines were normal."

Remark: This case would now be classed as one very unfavorable for radical cure on account of the extensive involvement of the seminal vesicles and intervesicular space. The examination of tissues removed showed that an early recurrence was to be expected. The fact that the patient lived nearly two years in comparative comfort was surprising.

CASE IV.—*Carcinoma of the prostate and lower part of the intervesicular region. Radical operation. Apparent cure. Now well, four and one-half years after operation.*

J. E. D., Of. No. 930. Aged 64; married. Admitted May 12, 1905. (See p. 517, Johns Hopkins Hospital Reports, vol. xiv) Onset one year ago with straining at urination. After one week the symptoms disappeared and he remained comfortable until seven months ago. The catheter then withdrew 16 ounces of residual urine, and after that he was catheterized once a day and treated by prostate massage by an osteopath. For two months he had used a catheter twice daily. Suffers no pain. Sexual powers normal. No hæmaturia.

Rectal: The prostate is considerably enlarged, more in the left lobe, which is hard but not stony, smooth, very tender. The right lateral lobe is moderately enlarged, oval, smooth, elastic, not tender, indurated but not so hard as the left. Neither seminal vesicle is apparently indurated, but on the left side several indurated cords are felt above the prostate. No glands, rectum negative.

Cystoscopic: Residual urine varies between 100 and 400 c.c.

No stricture. The lateral lobes are very little intravesically enlarged and the cleft between them is shallow. In the median portion there is a small sessile rounded lobe with a shallow cleft on each side. Trigone and vesical mucosa negative. With finger in rectum and cystoscope in urethra the beak is easily felt; no subtrigonal thickening, but by turning the beak to the left a distinct increase in the thickness of the left seminal vesicle is felt. Diagnosis carcinoma.

May 16, radical operation: Palpation of the prostate when exposed showed that it was very much harder than seen in hypertrophy. Radical operation was carried out without difficulty; the ureters were not injured. The trigone was excised to within 1.5 cm. of the ureteral orifices. One large gland adjacent to the left seminal vesicle was removed. Wound closed with catgut and silkworm gut sutures. No shock.

Examination of specimen: The prostate with its capsule and urethra, both seminal vesicles, vasa deferentia for a distance of 3.5 cm., cuff of the bladder 2 cm. wide in the region of the trigone, have been removed in one piece. Microscopic examination shows adenocarcinoma. The seminal vesicles and vasa deferentia are invaded near the prostate, but are free higher up. The trigone has not been invaded. The prostatic urethra is healthy.

Convalescence: The patient reacted well. The urethral catheter was removed on the seventh day. The silkworm gut sutures were not pulled out until the twenty-fourth day, and on the thirty-ninth day the perineal fistula was completely closed and urine passed through the penis but without control.

August, 1907: Patient reports for examination. Feels well. Weight 196 pounds. Has incontinence night and day. No pain or other discomfort. The urine is clear, no infection present. Careful examination of the rectum shows no recurrence.

September 15, 1909—Letter: "I am free from pain, weigh 195 pounds and am in excellent health. I am partially able to retain urine at night, and get up once to void. During the day I have complete incontinence and wear a urinal. Urine flows out freely without pain. No hæmaturia, no rectal disturbance or constipation. Sexual desire is present as much as ever, but I have no erection and am consequently unable to have intercourse."

CASE V.—*Carcinoma of the prostate and seminal vesicles. Radical operation. Death from shock. Autopsy showed extensive unrecognized peritoneal and deep glandular metastases.*

M. G., Of. No. 1052. Aged 75; widower. Admitted September 25, 1905. Onset eight months ago, with increased frequency and difficulty of urination which has rapidly increased. Now has severe pain in the bladder, rectum, membranous region, left thigh and knee. He has lost 16 pounds in weight and is very weak. Has not had complete retention of urine, but voids every twenty minutes.

Rectal: The prostate is moderately enlarged, is hard, but not stony and slightly elastic. The right seminal vesicle is not enlarged nor indurated. The left vesicle is negative but the left lobe of the prostate extends further up than the right and the induration may involve the lower portion of the seminal vesicle. Above the prostate, between the seminal vesicles, the tissues are firm and on the right side several hard cords can be felt along the pelvic wall. No enlarged glands are made out and the rectal mucosa is soft and not adherent.

Cystoscopic: A Coudé catheter cannot be introduced owing to obstruction at the apex of the prostate. A small silver catheter passes with ease and withdraws 80 c.c. residual urine. Bladder capacity 360 c.c. The cystoscope shows the median portion of the prostate moderately enlarged in the shape of a bar, and extending upward and to the left is an elevation of the trigone which is somewhat irregular; but the mucosa is intact. There is no ulceration or tumor to be seen in the bladder. The lateral margins of the prostate are a little irregular but not intravesically hypertrophied. With finger in rectum and cystoscope in urethra there is considerable induration beneath the trigone and the suburethral portion of the prostate is considerably thickened.

Remark: It is evident that the trigone is invaded, but owing to the absence of induration in the region of the seminal vesicles the radical operation is thought to be advisable.

October 13: Radical operation.—Excision of the prostate with its capsule and urethra intact, a portion of the membranous urethra, cuff of the bladder, nearly all of the trigone, including 5 mm. of the left ureter, both seminal vesicles and about 5 cm. of the vasa deferentia, all in one piece. When the prostate was freed examination showed no extension of the disease above the upper portions of the prostate and the seminal vesicles seemed to be healthy. On exposing the trigone it was found elevated and reduplicated in a mass continuous with the median portion of the prostate and extending up to the region of the left ureter which could not be seen. The line of incision was carried across the trigone just below the right ureteral orifice, above the ligamentum interuretericum, and just above the rounded elevation of mucous membrane seen at the upper left hand corner of the trigone. The left ureter could not be seen, but later examination showed about 5 mm. of the left ureter had been excised, the orifice being situated in the prominent mass above described. The upper end of the left seminal vesicle was very adherent to the peritoneum, and in freeing it a portion of the peritoneum was removed. It was found thickened and evidently involved. The patient lost more blood than usual, and at the end of the operation, which was more prolonged than usual, the etherizer reported his pulse as weak, but not very fast. Very soon, however, the respirations became alarming. He had been given 500 c.c. saline infusion during the operation and at the end was transfused with 700 c.c. Under this treatment his pulse became fairly good, but his respirations grew worse and he died about two hours after the operation.

Autopsy showed an extensive involvement of the peritoneum and numerous metastatic lymph-glands in the pelvis and along the great blood-vessels.

The operative and autopsy findings in this case were very unexpected. Rectal examination seemed to indicate that the disease had not spread far beyond the prostate, the seminal vesicles apparently being healthy. The appearance of the trigone, however, should have warned us against attempting a radical excision because, although not ulcerated, the irregular elevation evidently meant infiltration. There was, however, nothing to indicate that the disease had spread into the peritoneal cavity and, in fact, this case is unique in this respect as we have found no similar case.

CASE VI.—*Carcinoma of prostate. Seminal vesicles not invaded. Radical operation. Recovery. Well six months later.*

L. A., No. 2166. Aged 68; widower. Admitted April 8, 1909. For one year the patient had frequently suffered with imperative urination, during which the desire would come on suddenly and urination was very frequent. For several days after an attack he would be normal for three or four days. During the past month urination has been extremely frequent, so that he has begun to wear a urinal. Now voids very frequently night and day.

Examination: Patient is well preserved; no general glandular enlargement.

Rectal: The prostate is enlarged on the right side. The left lateral lobe is normal in size, smooth, very slightly indurated. The right half of the prostate is rough, irregular, markedly indurated, the induration extending to the median line and there ending abruptly, forming an almost straight declivitous edge. The induration on this side extends forward for about 3 mm. along the membranous urethra and backward to the junction of the seminal vesicles and vasa deferentia. The seminal vesicles and vasa deferentia can both be easily felt, but are apparently not more than slightly indurated and not enlarged. No enlarged glands. No intravesicular mass. Rectum negative.

Cystoscopic: Retention of urine complete. Bladder capacity 650 c.c. The cystoscope shows a small rounded median bar with no sulcus on either side. The lateral lobes are slightly thickened and the whole prostatic margin a little irregular, with some swelling of the mucous membrane produced by the retention catheter. The trigone is not elevated nor enlarged. With finger in rectum and cystoscope in urethra there is no subtrigonal thickening, but there is a definite increase in the suburethral portion of the prostate, and the left lobe is considerably indurated.

April 21, 1909: Radical excision of bladder, seminal vesicles and cuff of bladder. The tractor was inserted without difficulty and the prostate exposed easily. It was very hard, particularly the right lobe, which was stony. An incision was made and the capsule gaped widely and did not bulge nor show spheroids as in benign hypertrophy. A section was taken for microscopic study (stained frozen sections) and report was received that it was very dense fibroid tissue. The usual conservative perineal prostatectomy was then carried out, two small lateral lobes and a small median bar being enucleated. The tissue removed showed no spheroids, was very firm, fibrous, with small yellowish areas scattered throughout, and so thoroughly suggested carcinoma that a second section was obtained and showed definite carcinoma. Radical operation was then begun and carried out without much difficulty. The upper portion of the trigone was left intact, both ureters having been ligated. Anastomosis was easily completed with alternate catgut and silkworm gut sutures. Condition of patient excellent. Infusion on return to ward.

Convalescence: The patient convalesced slowly and the fistula was very slow in completely healing. He was discharged on the seventy-second day in good general health, with complete incontinence.

October 26: Letter—"I have gained much in weight; have no pain. Incontinence is still present."

Analysis of the Six Cases in which Radical Operation was Performed.—The ages of the patients were 70, 64, 65, 64, 75, and 68 years respectively, and symptoms had been present 11 months, 3 years, 4 years, 1 year, 8 months and 1 year respectively. Physicians had been consulted and treatment given 8 months before in one case, and 7 months before in another. In both of these cases an osteopath was employed who gave prostatic massage, thus losing valuable time. One case was subjected to a Bottini operation 6 months before admission. In all cases sufficient symptoms were present to warrant rectal examination by which a diagnosis could have been made long before the patient applied for treatment with us.

The onset symptoms were difficulty and frequency of urination in all cases except Case I, in which the first symptom was pain in the urethra. Three cases, II, IV and VI, had never suffered any pain. In the other three cases pain either local or referred was a prominent symptom. On admission, urination was extremely frequent and difficult in all cases except Case IV, in which a catheter was used twice daily.

The prostate was described as considerably enlarged in 3 cases, moderately enlarged in 2 cases and slightly enlarged in 1 case. Marked induration was present in all cases, involving the whole prostate in 4 cases. In Case IV, one lobe was indurated, but less so than the other and distinctly elastic. In Case VI the marked induration was confined to half of the prostate, the other being very slightly indurated.

The seminal vesicles were found on rectal examination to be free from infiltration or induration in 4 cases (II, IV, V, and VI). An area of induration between the seminal vesicles was present in Cases I, II, III and V. The catheter showed 400, 300, 500, 400, 80 and 600 cc. residual urine respectively.

The cystoscope showed a slight elevation of the median portion in 5 cases (I, II, III, V and VI). In Case IV there was a small, definitely rounded median lobe with a shallow cleft on each side.

The lateral lobes were scarcely at all enlarged intravesically in every case. There was generally not even a sulcus between them in front, but in 2 cases it was shallow. The vesical mucosa was everywhere intact, but the cystoscope showed, in 2 cases, an elevation of the trigone, which involved only the anterior portion in Case II. In Case III, the trigone was considerably elevated and irregular extending out on the left side as far as the ureter. In 4 cases the trigone was negative.

At operation, the lower ends of both ureters were intentionally excised for a short distance in Case II, the operator thinking that the disease had reached this point. This was a mistake, as it was afterwards found that the induration was inflammatory in character. In Case V the lower end of the left ureter was involved and had to be excised. This patient died of shock, and autopsy showed that while the seminal vesicles were free, the disease had travelled into the peritoneal cavity. The cystoscopic evidence of elevation of the whole trigone should evidently militate against the radical operation, as shown by this case. In Case III, the lower end of the left ureter was unintentionally divided by scissors in making the division along the left lateral wall of the bladder. Anastomosis was made high up and no inconvenience resulted (the patient living three years). In 5 cases the operation was carried out with apparent success and without shock, but a study of the specimen removed showed carcinoma near the upper limit in 2 cases (I and III). In Case V (patient dying of shock) autopsy showed extensive carcinoma of the peritoneum and retroperitoneal glands, although the bladder and seminal vesicles were free from invasion. In Case I the patient died nine months after the operation as a result of traumatism and infection, in attempting to remove a stone adherent to a silk suture. Autopsy showed a very small area of recurrence back of the bladder. In Case III, the patient lived over three years in comfort, but autopsy showed metastases in various parts of the body, the bladder and urethra, however, being free from ulceration. In Case II, in which the patient died six weeks after the operation from ascending renal infection, as a result of the intentional but injudicious division of the two ureters, extremely careful examination of all the pelvic tissues at autopsy with numerous sections taken for microscopic study failed to reveal any evidence of carcinoma and it seems probable that the disease had been completely eradicated. Two patients are alive and apparently well. One six months after the operation and the other four and a half years after the operation. In both of these cases the specimens showed that the disease had not reached the upper line of excision, and in one case at least the lapse of times seems to insure a radical cure.

As a result of the experience gained in these 6 cases it may be said that the operation should not be attempted where the infiltration extends more than a short distance beneath the trigone as determined by the cystoscopic examination with the finger in the rectum and the cystoscope in the urethra; nor where the upper portions of both seminal vesicles are involved; nor where an extensive intervesicular mass or indurated lymphatics or glands or involvement of the membranous urethra or muscle of the rectum shows that the disease is manifestly too far progressed; that the ureteral papillæ should be left intact with sufficient tissue below them to insure proper suture and to leave their openings free from constriction, 1 or 2 cm. above the wound; that hemorrhage should be carefully checked (by hugging the capsule, injury of the periprostatic plexus may be largely avoided); that silk should never be used and catgut only when occasional stitches of silkworm gut are employed to hold the tissue together in making the urethrovesical anastomosis; that when the operation is attempted early it can be performed without much danger or great difficulty and with excellent chance of cure; that only 3 of the 6 cases above recorded were suitable for the radical operation and that in all of these the disease was apparently completely removed and one is now apparently well four and a half years after the operation.

TECHNIC OF CONSERVATIVE (PARTIAL) PERINEAL PROSTATECTOMY.*

Position of the Patient.—The exaggerated dorsal position of the patient is the most satisfactory, and the perineal board devised by Halsted is admirably suited for this purpose. The perineum should be so elevated that it is almost parallel with the floor, thus allowing excellent retraction of the rectum and splendid exposure of the posterior surface of the prostate. After placing the patient upon the table, before elevating the thighs, a No. 24-F sound should be inserted into the posterior urethra, to be used subsequently as a guide for urethrotomy. If the operator waits until the patient is placed in the urethrotomy position, he will frequently find it difficult to introduce the sound through the triangular ligament.

Cutaneous Incision.—The inverted V cutaneous incision unquestionably gives a much better exposure than a median incision. The apex should be just over the posterior part of the bulb, about 2 inches in front of the anus, and the lateral branches directed outward and backward parallel to the ischiopubic ramus, each about 2 inches in length, as shown in Fig. 23. The incisions are carried through the skin, fat, and superficial fascia, and then by blunt dissection with the handle of the scalpel and the index finger of the left hand the space to each side of the central tendon is opened up. In this way it is very simple to open up by blunt dissection very quickly a space on each side reaching as far as the triangular ligament. In so doing the levator ani is pushed backward and outward on each side and the transverse perineal muscles are pushed forward.

Exposure of the Membranous Urethra.—The bifid retractor is inserted as shown in Figs. 24 and 25. Traction upon this instrument gives an excellent exposure of the narrow band of central muscle and tendon and greatly facilitates the division close to the bulb without injuring the hæmorrhagic structure. After the central tendon has been completely divided and the posterior surface of the bulb freed, it is well to insert a grooved retractor (Fig. 26), by which the bulb is drawn upward and a better view obtained of the recto-urethralis muscle, which lies between the two branches of the levator ani and covers the membranous urethra, toward which it draws the anterior wall of the rectum. In dividing the recto-urethralis muscle care should be taken not to injure the rectum, which is often drawn forward so that it lies almost in front of the membranous urethra. It nearly always covers the apex of the prostate. As soon as the recto-urethralis has been thoroughly divided it is easy by blunt dissection to push the rectum backward and thus obtain a good view of the membranous urethra, the bulb being drawn forward along with the muscular structures of the triangular ligament. The membranous urethra is then opened upon the sound (Fig. 27) and the edges picked

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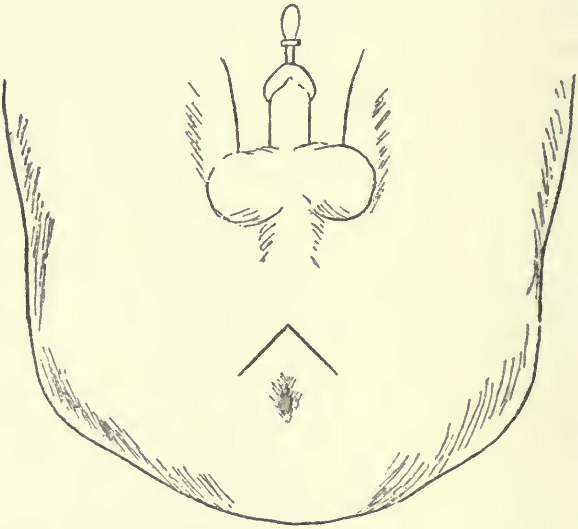
* For a more detailed description see Vol. xiv, Johns Hopkins Hospital Reports.

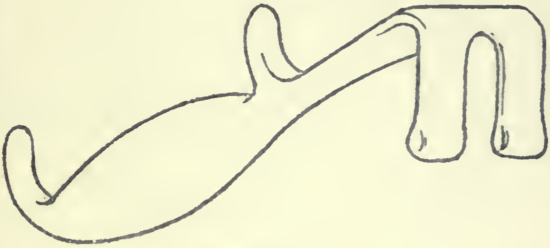
Fig. 23.



The inverted V cutaneous incision.

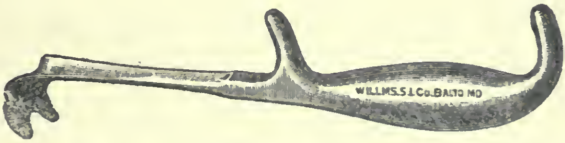
up with artery clamps, being sure to secure the mucous membrane. A sound is then inserted into the bladder through the urethral wound (an assistant having withdrawn the sound from the anterior urethra), to open up the way for the prostatic tractor,—and in these cancerous cases it may be necessary to stretch the contracted posterior urethra considerably before it is possible to insert the tractor into the bladder through the perineal urethrotomy wound. Owing to the rectangular shape of this instrument (Fig. 28) it is sometimes difficult to insert. Sometimes it is well to begin its introduction with the beak turned backward, and then to rotate the instrument 180 degrees before carrying it into the bladder. After the instrument has penetrated into the prostatic urethra it is generally advisable to remove the anterior bulb retractor, and thus allow the shaft of the tractor to be carried further forward. As a rule, little difficulty is experienced in inserting the tractor if one has been careful to secure the edges of the mucosa of the membranous urethra. After reaching the bladder the blades of the tractor are opened out by means of the external handles (Fig. 29), and after being fixed in this position by means of a

FIG. 24.



Bifid retractor.

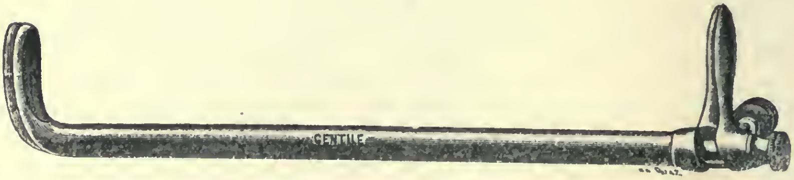
FIG. 26.



Retractor grooved so as to surround the membranous urethra and retract the triangular ligament and bulb.

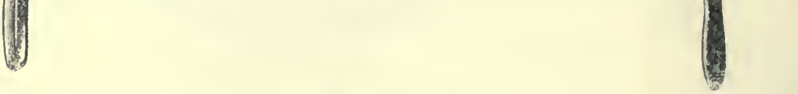
set screw, traction is made upon the prostate, and the further separation of the rectum from the posterior surface of the prostate made. After dividing the recto-urethralis muscle and exposing the apex of the prostate one generally finds it necessary to use the knife to divide a layer of fibrous tissue which lies behind the posterior surface of the prostate. After this (the posterior layer of Denonvilliers' fascia) has been divided the rectum can be more easily pushed backward, and one enters, generally with ease, into the space between the two layers of Denonvilliers' fascia, and the smooth glistening surface of the prostate is exposed. When this layer is properly exposed, no difficulty is generally experienced in rapidly freeing the entire posterior surface of the prostate and seminal vesicles, a good view of which is obtained at once by the insertion of a broad angular retractor.

Fig. 28.



Prostatic tractor closed. (Illustration of old model. In new model blades join staff at a slight angle.)

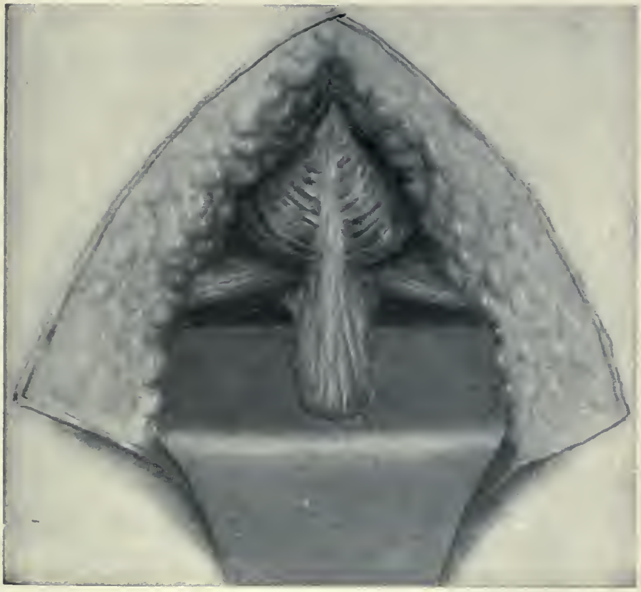
Fig. 29.



Prostatic tractor opened.

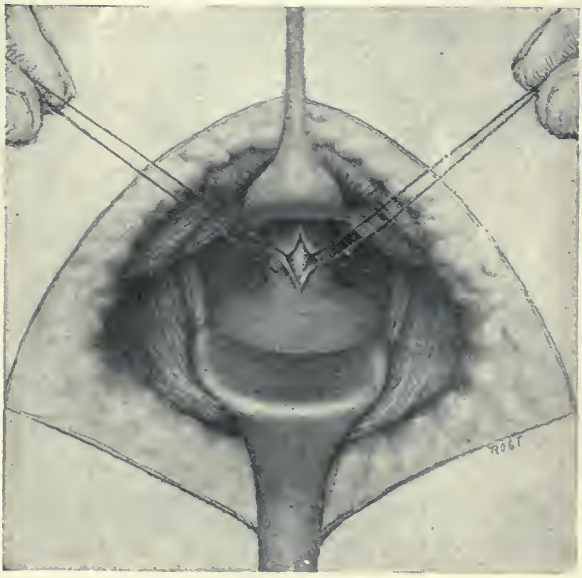
Incision of Capsule.—Lateral retractors are so placed that with posterior retractors drawing backward and the prostatic

FIG. 25.



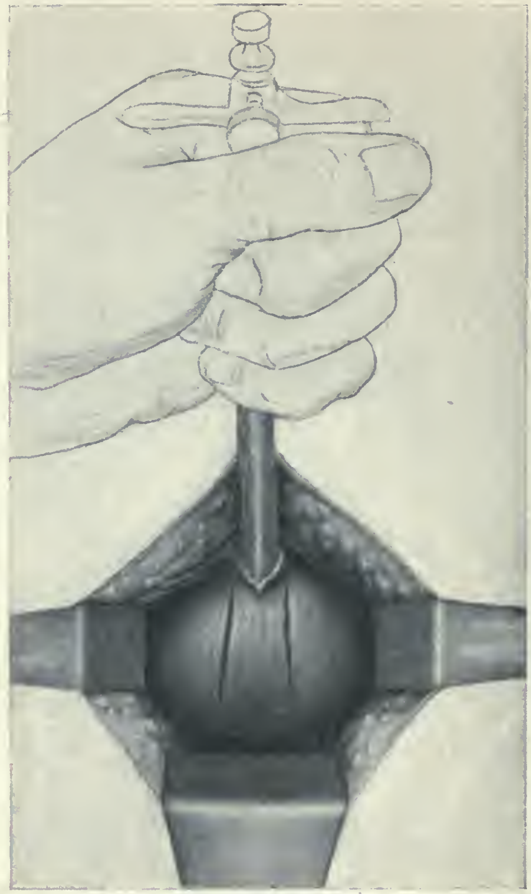
Showing the bifid retractor in use. Bulb and transversus perinei muscles and central tendon exposed.

FIG. 27.



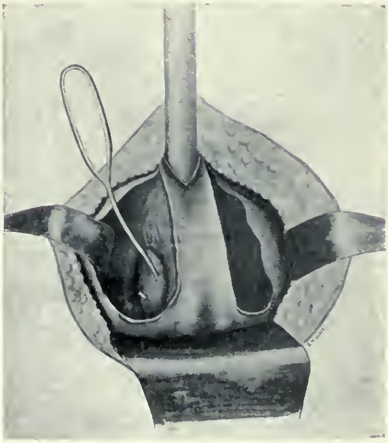
Opening of urethra on sound preparatory to introduction of tractor.

Fig. 30.



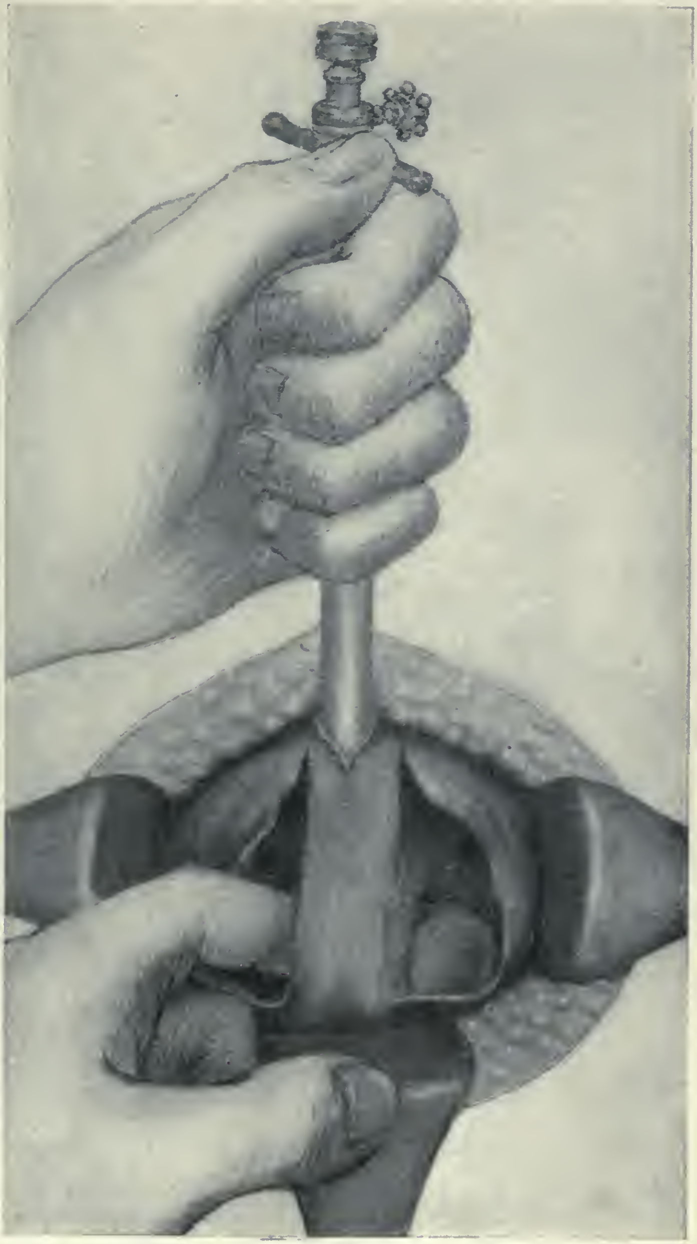
Tractor introduced, blades separated, traction made exposing posterior surface of prostate. Incisions in capsule on each side of ejaculatory ducts and urethra 1.5 cm. deep.

Fig. 31.



Showing removal of a fibrous median bar.

FIG. 32.



Showing technic of delivery of a rounded middle lobe into the left lateral cavity.

tractor drawing the gland outward a splendid exposure of the posterior surface of the prostate is obtained. An incision is then made through the capsule on each side of the median line for almost the entire length of the posterior surface and about 1.5 cm. deep. These incisions are about 1.8 cm. apart behind and 1.5 cm. apart in front, as shown in Fig. 30. The bridge of tissue which lies between them contains the ejaculatory ducts and the floor of the urethra.

The lateral lobes are then each completely removed, much of this being done by the blunt dissector. When the deep portion is reached—that is, at the base of the seminal vesicle and the bladder—it is often necessary to use a sharp periosteal elevator or a curette in order to completely remove all of the carcinomatous prostatic tissue in that region. The entire lateral mass of prostatic tissue usually comes away in one piece. but in those cases in which the cancer is confined to the posterior subcapsular layer in front of which is a hypertrophied adenomatous lobe, the latter is usually separately enucleated. After the two lateral cavities are emptied the median portion of the prostate is next attacked. This is indicated in Fig. 31, in which the median portion is shown diagramatically, caught with a sharp hook. It should be our object here to excise this median suburethral portion without injury of the ejaculatory ducts which lie behind it (in order thus to avoid epididymitis), and with as little injury to the urethra in front of it as possible. For this purpose an instrument, which we call a "punch" has been very satisfactory in that it forces out into of the lateral cavities a large mass of median portion. Remaining tissue can be removed with scissors, curette or rongeur. If a rounded middle lobe is present it may be drawn down and removed through a lateral cavity (Fig 32). It is then advisable to remove the tractor and dilate thoroughly the external prostatic orifice with a large forcep after removal of the tractor. The finger is then inserted through the urethra and an examination of the vesical neck made. As a rule the sphincter will be found tight, or often sclerotic, and thorough dilatation should be made. If there remains any prostatic tissue in the median portion or elsewhere around the orifice this can easily be enucleated or excised, using the finger as a tractor. In some cases carcinomatous infiltration continuous with the median bar and extending beyond the trigone is felt and it may be advisable to more or less completely remove this (which can usually be done with ease with a curette working upon the finger in the bladder against the trigone as a guide). Care should be taken not to tear a hole in the urethra or bladder; but it is a remarkable fact that although not infrequently the urethra has been torn into laterally or posteriorly during some of my operations, and in a few cases a small portion excised, the healing in all these cases has been entirely satisfactory, and there has been no evidence of intra-urethral or intravesical ulceration or tumor outgrowth through the rent. If a globular median lobe is present this is usually easily enucleable as in cases of benign hypertrophy. The rest of the operation is similar to that for benign cases: a large two-way drainage tube through the urethra into the bladder, continuous irrigation begun at once, the lateral cavities packed each with a single strip of iodoform gauze, the levator ani muscles drawn together in front of the rectum with a single suture of catgut, and the skin approximated by interrupted sutures of catgut. If the patient is very weak an infusion is often begun at the beginning of the operation, but usually we wait until the return to the ward. From 500 to 800 c.c. is generally given beneath one of the breasts. Continuous irrigation, begun on the operation table, is continued in the ward and, as the hemorrhage becomes less, the rapidity of the flow is cut down. In this way very little trouble is experienced in keeping up the irrigation for 24 hours. The patient is given water to drink as soon as possible and an effort is made to make him take as much as he can. The gauze is generally removed on the morning after the operation and the tubes during the afternoon when all bleeding following the removal of the gauze has ceased. On the following day the patient is usually put in a wheel-chair and taken out-of-doors, and as a rule the convalescence is as rapid and satisfactory as we see after perineal prostatectomy for benign hypertrophy. In fact, owing to the small size of the cavity the closure of the fistula and restoration of normal urination is usually somewhat quicker, as shown by reference to the detailed report elsewhere of cases treated by perineal prostatectomy.

Records of Nineteen Cases of Perineal Prostatectomy.—The results obtained by a conservative perineal prostatectomy (in which the urethra is preserved intact, the median and lateral lobes being shelled out from the capsule as completely as possible and the internal orifice of the urethra dilated with forceps) have been so surprisingly good that it seems wise to give the cases in detail. I have accordingly grouped them in classes:

CLASS I.—"PERFECT" FUNCTIONAL RESULT; I.E. COMPLETE RELIEF OF URINARY OBSTRUCTION AS LONG AS THE PATIENT LIVED.

There are 5 cases in this class, aged 72, 64, 82, 55 and 57 years. Prostatic symptoms had been present 6, 3, 7, 2 and 6 years and the patients lived 3½, 2½, 2 years, 10 and 4 months respectively after the operation. The relief of urinary obstruction and pain afforded by the operation in these cases was indeed splendid.

CASE VII.—No. 576. D. C.,; aged 72; widower. Admitted March 15, 1904. Urinary obstruction for three years. Acute retention of urine, greatly distended bladder, fever and uræmia on entrance. Extremely weak. Preliminary treatment necessary for five weeks. The prostate is only slightly enlarged, smooth, very hard. The seminal vesicles are palpable and indurated. The cystoscope shows a small median bar, slight lateral enlargement, no sulci. Diagnosis, "fibrous prostate."

April 22, 1904: Perineal prostatectomy. Lateral lobes removed. Vesical orifice dilated. Median portion not removed. Convalescence satisfactory. Fistula healed on the thirty-fourth day. Discharged on the thirty-seventh day, voiding naturally without pain at frequent intervals.

Ultimate result: Microscopic examination showed carcinoma and patient returned at our request for examination two years later. The seminal vesicles were then markedly involved and the cystoscope showed marked elevation of the trigone, but no ulceration. The patient was still able to void urine without very much difficulty at intervals of two or three hours. Bladder was somewhat contracted. He had no pain. He lived in comparative comfort until October 9, 1907, three and one-half years after the operation. He never required catheterization, had no hæmaturia, no pain in voiding and could retain urine for two hours. Died of emaciation.

Note: The result obtained in this case was indeed brilliant, as the patient was almost dead with uræmia when admitted to the hospital. (Case X, p. 559, vol. xiv, J. H. H. Reports.)

Case VIII.—J. E. H., No. 1102. Aged 64; married. Admitted November 4, 1905. Onset six months before with pain on urination. Gradual increase in difficulty. No hæmaturia. Yesterday complete retention of urine, impermeable stricture. Prostate slightly enlarged, irregular, very hard, and at the base of the right seminal vesicle there is a small area of induration continuous with the prostate. Upper portions of the seminal vesicles negative. Membranous urethra thickened and hard. Rectum negative. Malignancy suspected, but it was thought possible that inflammatory stricture and prostatitis was present.

Emergency operation at patient's home. The tissue removed suggested carcinoma, but it was not positive, as a freezing microtome was not at hand; conservative perineal prostatectomy therefore performed.

After a tedious convalescence with a secondary minor operation patient had an excellent result, and lived for two years and eight months. Up to his death he voided freely at normal intervals—no pain, no hæmaturia; no urinary discomfort of any sort. Chief complaint—severe constipation due to rectal stricture. Died of metastases to bronchial glands.

Case IX.—J. B. G., No. 1584. Aged 82; married. Admitted May 23, 1907. Onset five years before with difficulty and frequency of urination. Incomplete retention, catheterization for one year, now four times daily. Of late considerable inflammation in the region of the prostate. Dull pain in back and pubes. No hæmaturia.

Left lobe prominent, rounded, fairly hard. Right lobe considerably enlarged, smooth, soft, compressible. Right seminal vesicle rough, enlarged, and indurated. Left vesicle more irregular and harder than right, with a considerable mass in the intervesicular region. No enlarged glands, rectum negative.

Cystoscopic: Residual urine 200 c.c. Bladder capacity 400 c.c. The cystoscope shows an irregular median bar of moderate degree. No clefts, no lateral enlargements. Trigone irregular, thickened, not ulcerated. With finger in rectum and cystoscope in urethra there is a marked increase in the induration in the suburethral and subtrigonal tissues. Diagnosis of carcinoma made. Owing to difficulty of catheterization patient and physician demanded operative relief.

May 27, 1907: Perineal prostatectomy. Beneath the posterior capsule was definite carcinoma both sides. The right lateral lobe was soft, easily enucleated adenomatous hypertrophy. Median portion of the prostate slightly hypertrophied; no carcinoma. Left lobe was entirely carcinomatous. Urethra preserved.

Convalescence: Out of bed on the third day. Urine through penis on the tenth day. Discharged on the thirty-second day, able to retain urine for five hours, voiding freely without pain.

November 21, 1907: Letter.—"I void freely, twice at night; very slight pain in urethra. Have not required a catheter. No incontinence."

Patient died May 14, 1909, two years after operation. His physician writes that urination remained fairly normal, intervals two and one-half hours. No blood, no pain. Catheter not necessary. Obstruction of bowel gradually supervened. Operation entirely successful in relieving urinary obstruction.

Case X.—J. T. C., No. 1730. Aged 55; single. Admitted November 21, 1907. Onset one year ago with frequency of urination. A little later pain at the beginning and end of urination. Complete retention four months ago. Catheter life since. For two months severe pain in back, rheumatism in shoulder, wrist, knees and ankle. No pain in rectum, perineum, groins or along the sciatic nerve. Prostate a little enlarged, flat, irregular, markedly indurated, immovable. Left seminal vesicle markedly involved, right negative.

Cystoscopic: Stricture of anterior and prostatic urethra.

Somewhat irregular median lobe. Lateral lobes not enlarged. Trigone elevated, irregular, not ulcerated. Bladder negative. With finger in rectum and cystoscope in urethra marked increase in subtrigonal and suburethral thickness. Diagnosis of carcinoma made at once.

November 25, 1907: Perineal prostatectomy. Both lobes completely infiltrated, and also the median bar. Urethra preserved. Considerable subtrigonal thickening.

Convalescence very satisfactory. Out of bed on the second day. Urine through penis on third day, incontinence ceased on fourth day, and patient was able to hold urine for one hour. Fistula healed on the eighth day and patient was discharged on the twelfth day able to retain urine for four hours. Stream large, no pain.

April 9, 1909: Letter.—"Patient died September 24, 1908, ten months after operation. He was completely relieved of catheter, voided freely, able to retain urine for six hours. No hæmaturia. Before death considerable difficulty in moving bowels and pain in back. Operation gave complete relief from obstruction to urination."

Case XI.—J. W. C., No. 1810. Aged 57; single. Admitted March 8, 1908. Onset six years before with frequency, urgency, irritation and occasionally sudden stoppage of urine. One year ago pain in the right leg. Six months ago voiding every hour, catheterized and 48 ounces residual urine found,—since then catheterization twice daily.

Prostate and seminal vesicles are both considerably enlarged, markedly indurated, smooth. Prostate of stony hardness. Membranous urethra infiltrated.

Cystoscopic: Coudé catheter will not pass. Silver catheter shows 650 c.c. residual. The cystoscope shows a small lobular median bar and a small rounded tumor in the trigone near the right ureteral orifice. The tumor is composed of two portions and is covered with smooth mucous membrane, no ulceration anywhere. Diagnosis carcinoma.

March 16, 1908: Perineal prostatectomy. The lateral and median portions of the prostate were entirely carcinomatous, but easily enucleated. Urethral orifice tight, dilated.

Convalescence: One week after operation began to void through urethra. Discharged on the twenty-sixth day voiding naturally, able to retain urine for five hours. Suffers severe pain in right hip, thigh and leg also left leg and back.

May 9, 1908: Letter.—"The operation seems to be a success, except slight leakage through fistula when I make water."

September 13, 1909: Patient died one year ago, four months after operation. Up to the time of death urination was fairly normal—every two to three hours. He suffered pain in the right leg. Perineal fistula was present. General result of operation was good.

CLASS II.—PATIENTS STILL ALIVE AND COMPLETELY RELIEVED BY THE OPERATION OF CONSERVATIVE PERINEAL PROSTATECTOMY.

There are ten patients in this class, aged 60, 62, 61, 61, 78, 67, 75, 67, 79, and 75 years. Symptoms present 2, 2½, 15, 10, 4, 1, 1, 1, 3 and 1 year, and all alive and completely relieved 6, 1½, 1½, 1 year and 9, 7, 7, 4, 3, and 3 months respectively after the operation.

Two cases were of interest because the carcinoma was localized to a small area in the prostate and apparently completely removed with the lateral lobes. Both of these patients, Cases XII and XIV are apparently completely cured now 6 and 1½ years after operation. In another case, not tabulated here, which was operated upon by an assistant, a similar, small nodule of carcinoma was found in the anterior commissure of the prostate. These are the only cases in which carcinoma was discovered extremely early. The case (XIV) in which prostatism has been present for 15 years was a chronic prostatitis with a small area of carcinoma and the case in which the symptoms had been present for 10 years was one of hypertrophy of the middle and lateral lobes with carcinoma of the posterior portion of the prostate.

The results in these 10 cases have been extremely satisfactory. There has been no hæmaturia in any cases since the operation and no evidence of vesical tumor formation. So far they bid fair to give final results as completely satisfactory as in Cases VII and VIII. Two patients (XII and XIV) have been apparently completely cured.

Case XII.—J. T. Y., No. 463. Aged 60; married. Admitted September 24, 1903. Onset two years ago with frequency of urination. Suprapubic drainage six months. Prostate considerably enlarged, smooth, rather hard in consistency. The seminal vesicles not palpable, but both lateral lobes extend upward and are quite closely adherent. The cystoscope shows two lateral lobes. With finger in rectum and cystoscope in urethra there is very little median enlargement.

October 4, 1903: Operation—perineal prostatectomy. Lateral lobes were surprisingly small and adherent, but were apparently completely removed. No median lobe present. The wound healed well but urination was never free.

December 6, 1907: General health excellent. Urination difficult. Residual urine 760 c.c. The cystoscope shows large intravesical lateral lobes (same as before operation—evidently not removed).

Rectal examination showed cicatricial induration, but no carcinoma of prostate or seminal vesicles.

Operation: Perineal prostatectomy. The rectum was very adherent and a small tear was made into it. Two considerably enlarged adenomatous hypertrophied lateral lobes easily enucleated. No evidence of carcinoma. Rectum sutured.

Remark: Study of the tissue removed at first operation showed everywhere benign hypertrophy except in one small area which was definitely carcinomatous, but apparently completely excised. (See J. H . H. Reports, Case IX, p. 556.)

October, 1909: Letter.—"I enjoy good health—urination fairly free. No pain." Now six years since the lobe containing cancer was removed.

Case XIII.—A. W. C., No. 1814. Aged 62; married. Admitted March 9, 1908. Onset two and one-half years ago with pain in the rectum. For the past year gradual increase in frequency and difficulty of urination. No hæmaturia. The prostate is moderately enlarged, irregular, markedly hard. Induration extends forward along the membranous urethra and backward into both seminal vesicles, and on the right side extends far backward along the pelvic wall. No enlarged glands. Rectum negative.

Cystoscopic: Residual urine 60 c.c. Bladder capacity 220 c.c. The cysotscope shows a median bar. No lateral enlargement.

Anterior portion of the trigone elevated but not ulcerated. Bladder negative. Diagnosis carcinoma. Operation not advised but relief demanded by patient from frequency and difficulty of urination.

July 13, 1908: Perineal prostatectomy. The posterior surface showed very hard layer of cancer, but the lateral lobes contained adenomatous spheroids. Median portion was removed partly with scissors and curette.

Convalescence: Patient suffered considerably from pain. Urine began to flow through penis on the tenth day. Fistula healed in three weeks and patient discharged on the thirty-second day voiding urine naturally, occasionally slight incontinence.

September 1, 1908: "Condition good except pain in right sciatic nerve which is relieved by aspirin, 10 grains daily. Weakness of sphincter improving."

December 30, 1908: "Greatly improved. Good control. Intervals two to three hours. Pain present, but improved."

October 21, 1909: One year and seven months since operation. Result good. Voids freely, interval three hours. No incontinence, no hæmaturia (two months ago a few drops of blood before urination). Pain in right side of buttock, rectum, scrotum and thigh, none on left; completely relieved by 20 grains of asperin. Examination showed small mass in region of prostate involving the rectal muscle near the apex. Both seminal vesicles markedly involved. No stricture or ulceration of rectum. Urine purulent, a little blood.

Case XIV.—J. H. McI., No. 1898. Aged 61; married. Admitted May 19, 1908. Has suffered with prostatic trouble, irritation, and frequency of urination for over fifteen years. Three years ago began to have difficulty and pronounced frequency, which has gradually increased and he now voids every two hours and six times at night. Never passed a catheter. No hæmaturia. Pain in neck of bladder. The prostate is a little broader than normal, slightly indurated, smooth. Seminal vesicles negative. Prostatic secretion contains pus cells. Urine clear.

Cystoscopic: Residual urine 60 c.c. Bladder capacity 300 c.c. The cystoscope shows a small rounded median bar. Bladder negative. Diagnosis chronic obstructive prostatitis.

May 21, 1908: Perineal prostatectomy. When the capsular incisions were made the wounds gaped widely, as if on tension.

The lateral lobes were small and removed each in one piece. The median portion was larger than normal and excised through the left lateral cavity. Urethra and ejaculatory ducts preserved. Internal sphincter tight, but easily dilated. Examination of bladder negative.

Convalescence: On removal of tubes on day after operation the patient was able to retain his urine for a short length of time, but urine did not come through penis until the fourth day. Perineal fistula closed on the twelfth day. Patient discharged on the fifteenth day, able to retain urine for three hours.

September 15, 1909: Letter.—"I void naturally about every four hours and twice at night. No pain. General health good. I regard the operation as most successful."

October 1, 1909: Letter from physician.—"Rectal examination shows no evidence of carcinoma. Patient is well."

Case XV.—J. McI., No. 1998. Aged 61; married. Admitted October 18, 1908. Onset ten years before with difficulty of urination. Examination then showed enlarged prostate. For eight months catheter life, no severe pain, no hæmaturia. Prostate moderately enlarged, slightly irregular, indurated, in places stony, in others less so and distinctly elastic. Upper end of prostate is well limited; the seminal vesicles cannot be reached, but apparently there is no marked induration above the prostate. Membranous urethra thickened and indurated. No enlarged glands. Rectum negative.

Cystoscopic: Retention of urine complete. Bladder capacity 520 c.c. The cystoscope shows a slightly enlarged left lateral lobe, small irregular median bar, considerably enlarged right lateral lobe. Bladder negative. "With finger in rectum and cystoscope in urethra it is impossible to feel the beak of the instrument and there is considerable increase in the suburethral portion of the prostate, which is quite firm; but it does not seem sufficiently hard for a diagnosis of carcinoma, though the possibility of carcinoma has to be considered."

October 26, 1908: Perineal prostatectomy. Membranous urethra very thick, difficult to introduce tractor. Posterior surface of prostate slightly irregular, in places hard, in others elastic. Lateral incisions cut like cartilage and diagnosis of carcinoma was at once made from appearance of tissues. Examination showed that the seminal vesicles were involved, and as consent of patient had not been obtained the radical operation was not performed. The deep portions of the prostate showed some adenomatous lobules. Internal orifice dilated, median portion removed with curette.

The convalescence was very satisfactory. Patient left the hospital in about a month, able to retain urine for four hours, slight dribbling. Fistula healed.

September 14, 1909: Letter.—"I am perfectly normal, free from pain and the result is entirely satisfactory—could not be better."

Case XVI.—J. R., No. 1000. Aged 78; widower. Admitted June 6, 1905. Onset four years before with frequency and difficulty of urination. Catheter life for three months. No hæmaturia. Prostate moderately enlarged, round, smooth. The right lobe is the larger and is slightly indurated but elastic. The left lobe is smaller and soft. The seminal vesicles are not palpable, but there are indurated cords on the left side in this region. No intervesicular mass, no enlarged glands. Rectum negative. Catheter showed 250 c.c. residual urine. The cystoscope could not be introduced on account of stricture in the prostatic urethra.

Perineal prostatectomy. Examination of the lateral incisions showed a benign appearance and adenomatous hypertrophied lobes were enucleated on each side. At the upper end of the right lateral lobe the tissue was firmer and had to be excised with scissors; in removing it the median portion of the prostate and ejaculatory ducts were intentionally removed. Carcinoma was suspected, but the age and condition of the patient precluded radical operation.

Convalescence very satisfactory. He was discharged on the thirtieth day after operation, voiding urine naturally. Nine months later he returned for examination. He said he was cured. Voided urine at normal intervals without pain. General health excellent.

September 15, 1909: No trace of patient could be found.

Microscopic examination showed benign hypertrophy everywhere except at the upper portion of the right lateral lobe. This case would have been a good one for radical operation had he been younger and in better shape.

Case XVII.—W. H. D., No. 1821. Aged 67; married. Admitted February, 1908. Onset one year before with increased frequency and pain on urination. For three months used catheter occasionally. On admission catheterization very difficult, patient weak, uræmic.

On rectal examination in the region of the prostate was a fluctuating mass (probably hæmatoma from numerous attempts at catheterization). Catheter was finally passed and for two weeks continuous urethral drainage was maintained. Under this patient improved rapidly and perineal prostatectomy was performed without further examination. (Patient a public ward case.) As soon as the prostate was exposed carcinoma was suspected. The posterior surface was irregular, very firm and both seminal vesicles were involved in the induration. No adenomatous spheroids present. Considerable subtrigonal infiltration. Mucous membrane preserved. Median and lateral portions of prostate enucleated.

Convalescence: Out of bed on the second day. Urine through anterior urethra on the eleventh day. Perineal fistula closed on the fourteenth day. Discharged from hospital on twenty-second day, able to retain urine for three hours with perfect control; no pain.

Examination seven months after operation: Patient feels cured. Voids urine naturally about every four hours. Complains of pain in rectum, back and legs.

Rectal: The prostate is about normal in size, irregular, indurated. Immediately above is a soft smooth lobular mass which presses greatly upon the rectum and obscures the seminal vesicles. No rectal ulceration or stricture. It seemed probable that the mass was a blood cyst.

September 15, 1909: Patient could not be found.

CASE XVIII.—W. J. R., No. 1779. Aged 75; widower. Admitted February 4, 1909. Onset ten months before with sudden complete retention of urine. Catheter life since, now every four hours.

Prostate is moderately enlarged, bulges considerably towards the rectum. There are several small areas of marked induration: one in the median line near the apex of the prostate; one at the upper end of the left lateral lobe; one near the apex of the right lateral lobe. The rest of the prostate is fairly smooth, and although indurated not of stony hardness. The seminal vesicles are negative. Membranous urethra is thickened, slightly indurated and a hard nodule 3 mm. in diameter is felt at the juncture with prostate. Rectum negative. No enlarged glands.

Cystoscopic: Residual urine 210 c.c. "There is a moderate enlargement of the lateral lobes and a rounded median lobe. With finger in rectum and cystoscope in urethra the beak cannot be felt. The suburethral portion of the prostate anterior to the middle lobe is only moderately increased in thickness and moderately indurated, and it seems probable that the case is not carcinoma."

February 5, 1908: Perineal prostatectomy. Rectum very adherent. Considerable induration on the left side of prostate extending to the seminal vesicle. Right lobe soft. Small blood cyst and benign hypertrophy on the right side. On the left the capsular incision showed a layer of very dense tissue 1 cm. thick. Beyond was a moderately hypertrophied adenomatous lobe. The median lobe was also a benign hypertrophy. Diagnosis of carcinoma made on the table but radical operation not carried out because consent of patient had not been obtained,—this should have been done.

Convalescence very satisfactory. Perineal fistula closed on the twenty-first day; discharged on twenty-fourth day. Condition excellent. Voiding naturally.

September 1, 1909: Patient reports that he is very well. Voiding urine normally; no pain. Condition excellent. Result fine.

Note: This case would have been an excellent one for a radical operation.

Case XIX.—W. W. D., No. 2180. Aged 67; widower. Admitted May 11, 1909. Onset fifteen months before with difficulty and frequency of urination. For five months nocturnal incontinence. Of late severe nausea and vomiting—nausea every few minutes. No pain, no hæmaturia.

Prostate very little enlarged, smooth. Right lobe distinctly indurated, but somewhat elastic. Both seminal vesicles are slightly indurated. Rectum negative, no enlarged glands.

Cystoscopic: Residual urine 500 c.c. Intravesical globular enlargement of both median and lateral lobes. Small rounded anterior lobe. Bladder negative. With finger in rectum and cystoscope in urethra there was considerable increase in suburethral thickness; but the induration did not seem to be quite as firm as is usually seen in carcinoma, and on account of the presence of elasticity and rounded intravesical lobes the diagnosis of benign hypertrophy was made.

Perineal prostatectomy: The prostate was very adherent to the rectum and this at once suggested carcinoma. The consistence was very hard, induration extending to the base of the seminal vesicles. Beneath the capsule was a dense area of carcinoma on both sides. The anterior portions of the lateral lobes and median lobe showed benign lobular hypertrophy, the median lobe being quite prominent. Finger in the bladder showed the trigone infiltrated but not ulcerated.

Convalescence satisfactory. Urine through the anterior urethra on the sixth day. Perineal fistula healed completely on the twenty-first day. Patient discharged on the twenty-ninth day, able to retain urine for five hours, voiding freely without pain or hemorrhage. Feels well.

September 13, 1909: Letter.—"Urination is free, about eight times during the day and four times at night. Catheter not required. No hæmaturia, no pain; only annoyance is a pressure around the rectum."

Case XX.—R. I. B., No. 2220. Aged 79; widower. Admitted June 17, 1909. Onset three years ago with incontinence of urine. Eight months ago catheter showed 46 ounces residual urine. Since then catheter life—now five to six times a day—with considerable difficulty. No pain, no hæmaturia. Prostate is slightly enlarged, irregular, in places quite hard, in others moderately hard, nowhere stony. Both seminal vesicles are enlarged, irregular, indurated as far as the finger can reach. Membranous urethra thickened, but soft. Rectum negative, no enlarged glands.

Cystoscopic: Retention of urine complete. Bladder capacity 300 c.c. The cystoscope shows a small globular median lobe. Lateral lobes a little enlarged. Bladder negative. With finger in rectum and cystoscope in urethra there is considerable thickening beneath the trigone and the urethra, but not of stony hardness.

June 21, 1909: Perineal prostatectomy. The prostate was adherent to the rectum, and rough and hard—in places stony. Capsular incisions cut like gristle. Beneath the capsule was a layer of very hard tissue 1 cm. thick; in front of this soft adenomatous spheroids. Median lobe easily enucleated, not carcinomatous. Urethra torn but not excised.

Convalescence excellent. Up in chair on third day. Urine through penis on seventh day. Fistula closed on fourteenth day. Patient discharged on nineteenth day, able to retain urine five hours—no dribbling, condition excellent.

September 23, 1909: Letter from physician.—"Patient is very comfortable. Has not used a catheter. Voids urine not at all at night and at intervals varying from three to six hours in the day-time. No pain, no blood. Result splendid."

Note: Failure to make positive diagnosis before operation in this case was due to the elasticity and presence of intravesical lobes. Patient too old for radical operation.

Case XXI.—M. C., No. 2229. Aged 75; widower. Admitted June 30, 1909. Onset one year ago with difficulty and frequency of urination. Examination nine months ago,—7 ounces residual urine found. Since then catheter life,—now every three hours. Burning pain in bladder, aching pain in back, no hæmaturia. Prostate moderately enlarged, irregular, of stony hardness, and fixed. Above the prostate is a broad plateau of induration involving both seminal vesicles as far as the finger can reach. Rectum adherent, not ulcerated. Membranous urethra thickened. Cystoscopy not performed.

July 2, 1909: Perineal prostatectomy. Capsular incisions showed no spheroids, entire prostate being carcinomatous. The vesical orifice was tight. The trigone was infiltrated but not ulcerated. With a curette the subtrigonal induration was excised after the median bar. Examination of the urethra showed that the lateral walls were torn. Bladder negative.

Convalescence very satisfactory. Voided through urethra about the fourteenth day. Fistula closed twenty-third day. Discharged on the thirty-seventh day, voiding naturally every two and one-half hours. No residual urine. Bladder capacity 200 c.c.

September 15, 1909: Letter.—"I void urine naturally about once an hour. Have not used a catheter. No blood. No rectal trouble. I suffer pain in back and both hips. I am gaining in strength slowly. Perineal fistula not entirely healed, but only leaks during urination."

CLASS III.—GOOD IMMEDIATE RESULT, RECURRENCE OF OBSTRUCTION.

There are four cases in this class, patients aged 66, 66, 75, and 54 years, symptoms present 4½, 3½, 3 and 3½ years respectively.

In the first case the median bar was not removed and a recurrence of the obstruction was to be expected.

In the second case benign hypertrophy of the lateral and median lobes in front of the posterior layer of cancer was present. The operation was apparently complete, but obstruction recurred in six months. He is still alive two years after the operation.

The result in the third and fourth cases was also temporary (10 and 8 months).

Case XXII.—No. 227, T. R. Aged 66; married. Admitted August 9, 1898. Carcinoma of the prostate and seminal vesicles. Duration three years. Frequency of urination. Catheterism. Perineal prostatectomy. Median portion not removed. Good immediate result. Later return of obstruction and in less than a year patient had to resume the use of a catheter. Perineal fistula never healed, and later a large open sore appeared. A few weeks before he died the bladder ruptured into the bowel and the urine came away with stools. He died nineteen months after the operation.

Remark: The operation performed in this case, which was my first perineal prostatectomy, consisted of a preliminary suprapubic to push the prostate down and then the lateral incision in one side of the perineum. Exposure of the prostate, division of the capsule on each side of the urethra, leaving a block of tissue adjacent to the urethra. Both lateral lobes excised with scissors. Small tear made in the urethra. External urethrotomy through the external urethra for drainage. Suprapubic wound closed with sutures.

Convalescence: Patient reacted well. Gauze pack removed at the end of twenty-four hours and the urethral catheter at the end of the twenty-fourth day. Suprapubic suture of the bladder did not leak and patient did not require catheterization after operation. Perineal fistula did not heal although the patient remained in the hospital until December 17. Catheter then showed 50 c.c. residual urine. Bladder capacity 300 c.c. Urination more frequent than normal. Subsequently obstruction became worse and patient suffered greatly until death.

Case XXIII.—H. R. N., No. 1711. Aged 66; widower. Admitted October 19, 1907. Onset fifteen months before with pain in thigh and groin. Was treated by various methods without result. Eight months ago first had difficulty and frequency of urination. Massage of prostate then begun without relief. One month ago complete retention of urine. Catheter life since. Now suffers severely from pain in back and on inside of thigh and groins. Prostate irregular, very hard, tender. Right lobe continuous with an indurated mass which involves the right seminal vesicle. Left seminal vesicle negative. Considerable mass around the membranous urethra. A few small shot-like masses in muscle of rectum.

Cystoscopic: Residual urine 170 c.c. Bladder contracted. The cystoscope shows slightly rounded median lobe and two definitely enlarged rounded lateral lobes. Bladder negative, no ulceration.

October 25, 1907: Perineal prostatectomy. Considerable infiltration around the membranous urethra. Rectum very adherent. Subcapsular infiltration of carcinoma 5 mm. thick; beyond that soft adenomatous lobes easily enucleated.

Convalescence satisfactory. Urine through penis on fourth day. Interval urination on the fifth day. Out of bed on the second day. Fistula closed completely on the thirty-eighth day. Discharged on the forty-second day, voiding naturally at intervals from three to four and one-half hours. No pain, no hæmaturia.

September 17, 1909: Letter.—"For nearly a year there was a perineal fistula, but it is now healed. After about six months urination again became difficult and catheter was necessary. It is now employed about every five hours. Patient is failing rapidly."

Note: The result obtained in this case was not nearly so satisfactory as in most of the others.—Cause?

Case XXIV.—E. W., No. 1776. Aged 54; married. Admitted January 26, 1908. Great-grandfather, grandfather, father and three uncles all died of prostatic trouble, between the ages of 60 and 70. Onset two years ago with difficulty of urination. Urination now very frequent and difficult. No pain, no hæmaturia. Has never been catheterized. Prostate a little irregular, moderately indurated, very tender. Right lateral lobe is particularly irregular and indurated, extends along the membranous urethra and up into the right seminal vesicle. The left lobe is small, but also slightly irregular and indurated, as is also the left seminal vesicle. There is slight intervesicular induration.

Cystoscopic: Residual urine 40 c.c. Bladder capacity 240 c.c. The cystoscope cannot be introduced, obstruction at vesical orifice.

The following note was made: "The marked tenderness and induration of the prostate and vesicles suggest carcinoma, but the induration is not of stony hardness and suggests chronic inflammation engrafted on slight hypertrophy."

January 28, 1908: Perineal prostatectomy. When the capsular incision was made on the right side the tissue was gritty and no spheroids were present. Diagnosis carcinoma. His physician opposed radical operation and said patient would never consent to it. The right lobe was soft in places and not entirely malignant. Median bar markedly indurated. Finger in bladder showed no tumor nor ulcer. Subtrigonal induration.

Convalescence: This was very painful. Urine through penis on the eleventh day. Fistula closed on the twentieth day; interval urination established on the tenth day; discharged on the twenty-sixth day, voiding urine freely without pain at intervals of three hours.

September 4, 1908: Letter.—"Patient very comfortable. Voiding urine naturally about every one and one-half hours. Urine clear." October 25, 1908: Letter.—"Obstruction growing greater also obstruction to bowel movements."

January 18, 1909: Retention almost complete, catheterization difficult. Suprapubic cystotomy, discovery of an obstructing intravesical lobe.

February 15, 1909: Colostomy on account of rectal obstruction.

September 13, 1909: Patient is failing rapidly, emaciated.

Pain in rectum, bladder and abdomen. Colostomy, suprapubic cystotomy.

Note: The operative relief in this case lasted only six months. Still alive, one year nine months.

Case XXV.—J. J. S., No. 15199. Aged 75. Admitted September 18, 1903. Onset three years before with increased frequency and difficulty of urination. Catheter life for eighteen months. Spasmodic pain in perineum, no hæmaturia. Prostate considerably enlarged, slightly irregular, nodular, rather hard and adherent. Seminal vesicles not palpable. The cystoscope showed a small median bar. No vesical ulceration.

Operation: Perineal prostatectomy. Enucleation. Median portion of prostate excised with vasa deferentia and the lower end of one seminal vesicle. The patient did well after the operation, and two months later he could retain urine from five to seven hours. Fistula was healed and general condition good. Ten months after the operation the fistula opened and urination became difficult.

Examination showed 500 c.c. residual urine, and extensive carcinoma involving both seminal vesicles. The cystoscope showed a fairly large middle lobe and considerable enlargement of both lateral lobes. In the trigone was an irregular vesical tumor. The patient died a few weeks later.

Résumé.—A survey of the 19 cases reported in full above in which the operation of conservative perineal prostatectomy was performed shows no cases which were not benefited by the operation and in all but 4 cases almost complete relief and splendid comfort was afforded by the operation. Two cases (VII and VIII) were remarkable for the length of time (3½ and 2½ years) in which the patients lived in complete comfort, although the cancer spread upward involving the high pelvic structures, and in one case producing stricture of the rectum. Some of the cases in Class II bid fair to be as successful as the two above mentioned, as the patients are still in excellent health a year or more after the operation. Cases XII and XIV are remarkable in that they have been completely cured by the operation (one six years). In these cases, however, the diagnosis of carcinoma was not made before operation and the carcinoma which was present in each case was simply a small nodule in one of the lateral lobes, and was completely removed by the operation. These two cases show the very great importance of early operation in hypertrophy of the prostate even though carcinoma is not suspected. In both these cases, however, rectal examination showed distinct induration greater than that usually seen in hypertrophy, thus demonstrating the importance of suspecting carcinoma in all cases where any portion of the prostate is distinctly indurated.

The results obtained here in these 19 cases (lasting, practically complete relief of obstruction in 79 per cent. of the cases) show the very great value of this operation in cases of carcinoma in which the radical operation cannot be undertaken, but in which the patient is suffering with frequent, difficult or painful urination and where routine catheterization is either impossible or very difficult, painful or burdensome. One is almost tempted to say that the operation is generally advisable, but I think it is better to try to get along without it, using the catheter, if necessary, until the conditions described above supervene, when the operation may be easily undertaken. Great care should be observed in preserving the normal structures, particularly the mucous membrane of the urethra and vesical neck; but the operation should be very thorough particularly in the region of the median portion, and we should be sure that the prostatic orifice is well dilated and an examination made with the finger to see that all the obstruction has been removed, and to examine the trigone. If a considerable subtrigonal infiltration is discovered it may be advisable to remove it with the curette through the cavity left by the removal of the median bar. This was done in some of these cases. It is possible that in the 4 cases in which there was a recurrence of obstruction this recurrence was due to the fact that a mass of subtrigonal infiltration was not removed in any of these four cases.

Suprapubic Prostatectomy, Two Cases.—The prostate was enucleated in 2 cases, in both of which the malignant nature of the disease was not recognized. One of these was operated upon in 1898 by another surgeon and resulted in death thirty hours after the operation. Autopsy showed numerous pelvic metastases. In the second case I failed to recognize the malignant nature of the disease and performed a suprapubic prostatectomy after removing a very large vesical calculus. It was impossible to separate the prostatic lobes from the urethra and the entire prostate was shelled out in one mass along with the urethra. The malignant nature of the disease was not discovered until several years later, when the patient returned complaining of a tumor of the kidney. He reported that there was no difficulty or frequency of urination and that the operation had cured him completely. Rectal examination, however, showed an indurated mass in the region of the prostate, and study of the microscopic sections of the prostate removed at operation showed carcinoma, thus explaining the nature of the supposed kidney tumor. The patient died four years after the operation, having been entirely free from urinary disturbance.

Remark: The prostatic enlargement in this case was largely due to adenomatous hypertrophy. This probably accounts for the ease with which it was shelled out suprapubically. In cases in which there is no hypertrophy present, but the prostate is of the small, hard variety, as seen in many of our cases, it would seem almost impossible even to start the enucleation through the bladder and that for such cases a suprapubic prostatectomy is out of the question. The fact that the urethra comes away with the prostate in these cases is, I believe, a distinct objection to the suprapubic route even when the presence of intravesical adenomatous lobes makes it possible.

Bottini Operation, Seven Cases.—The Bottini operation was employed to relieve prostatic obstruction in 7 cases. In 4 of these cases the diagnosis of carcinoma was made, and the operation employed simply as a palliative procedure with distinct improvement in all four cases.

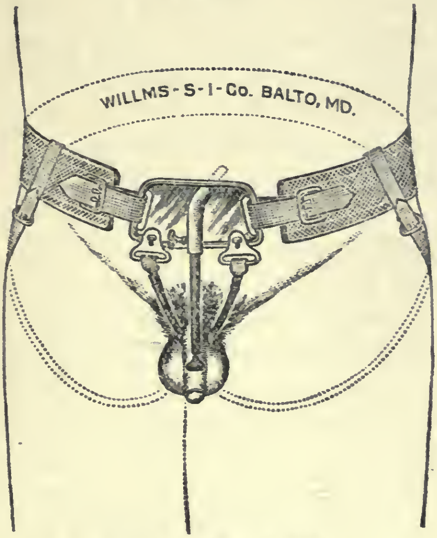
In 3 cases the malignant nature of the enlargement was not recognized, and the Bottini operation was employed, as I was using it to the exclusion of other methods at that time. The results obtained were very good in all three cases. In one case the obstruction recurred and the patient died within a year. In the second case the result was excellent for sixteen months when symptoms of obstruction again appeared, and suprapubic cystotomy for drainage had to be employed three years after the Bottini operation. The last case has been remarkable for the immense benefit conferred by the Bottini operation. For almost six years after the Bottini operation he lived free from pain and discomfort, although the prostate and seminal vesicles were markedly involved and general glandular metastases were present. A review of these 7 cases shows several remarkably good results with the Bottini operation, but, as a whole, perineal prostatectomy is the preferable operation where it is desired to relieve the patient from the necessity of painful and difficult catheterization, and the discomforts of life with a suprapubic drainage apparatus.

Castration, Two Cases.—Castration was performed for the relief of prostatic obstruction in 2 cases. In one case the operator did not recognize that the disease was carcinomatous, and performed castration, which was then in vogue, in order to produce an atrophy of the enlarged prostate. Suprapubic cystostomy for drainage was provided at the same time. The result was negative and the patient wore a suprapubic drainage apparatus until his death a year or so later.

In the second case, which was operated on by the writer, the diagnosis of carcinoma was evident. There was no frequency or difficulty of urination, but the patient complained of severe pain in the rectum, buttocks and limbs. No operation to relieve obstruction was indicated, and castration was performed with the hope that some change in the prostate, which might bring about relief of the rectal pain, might follow. The result, however, was negative.

Suprapubic Drainage, Twelve Cases.—In all these cases the catheter was tried first and the operation performed either because it was impossible to introduce the catheter or its use was so painful or difficult that the catheter life could not be endured. In several cases the patient employed the catheter for a long period before finally demanding operative relief. In nearly all of these cases the patient was far advanced in the disease and often in desperate shape. One patient died a week after the operation, one lived only a month, another only five months and a third six months. In these three cases the patient suffered very greatly and the operation afforded very little relief. In 2 cases it has been impossible to find the patient since his departure from the hospital. In 6 cases the drainage apparatus described by me elsewhere (Fig. 33) was employed, and in 5 cases all reports state that it worked well: there was no leakage around the tube, the patient was able to empty the bladder at fairly long intervals by opening the stop-cock, and there was very little pain or vesical discomfort. In one case a member of the family writes: "The tube was never satisfactory or comfortable, so that in about a year later a perineal prostatectomy was performed; the wound healed finely, the urine came painlessly through the natural channel. He lived six months in comfort." In contradistinction to this report is one from Dr. T. P. Lloyd in regard to another case

FIG. 33.



Suprapubic drainage apparatus.

in which he says: "Your drainage apparatus was a perfect success. At times he could go seven or eight hours without emptying his bladder and when he did there was no pain. The prostate in the latter months of his illness gave him no trouble. He died thirteen months after the suprapubic operation."

As noted above, the results obtained by suprapubic drainage were distinctly better when an apparatus was provided by which the bladder would be emptied only at stated intervals rather than being allowed to drain continuously. As a result, the bladder did not become contracted and the patient did not suffer from the constant pressure of the contracted bladder upon the end of the tube which is often present when continuous drainage is allowed. The one report, however, in which great relief afforded by perineal prostatectomy is cited, is a strong argument for the adoption of perineal prostatectomy instead of suprapubic drainage when a catheter life is not satisfactory.

Perineal Drainage, Two Cases.—In two cases median perineal urethrotomy was performed, in one case on account of abscess of the prostate involving the perineum, and in the second case on account of the inability of the patient's physician to pass a catheter, complete retention of urine being present. It is interesting to note that the physician reported that he found a stricture of the deep urethra, a condition which we have shown is frequently produced by carcinomatous involvement around the membranous and prostatic urethra. Except in suppurative conditions perineal urethrotomy has little to commend it.

Cases Treated by Catheterization.—There were 39 cases in which the patient was advised to lead a catheter life and no operation was attempted. In nearly all these cases the disease was too far advanced for a radical operation, but in many of the cases conservative perineal prostatectomy might have been performed with considerable relief. In order to compare the results obtained by the use of the catheter with those of prostatectomy we have attempted to get an accurate idea of the subsequent course of the cases.

The ages of the 39 patients were as follows: 50 years of age—1 case; 50 to 59 years—7 cases; 60 to 69 years—16 cases; 70 to 74 years—7 cases; 75 to 79 years—4 cases; 80 to 84 years—2 cases; not noted—2 cases. Total, 39 cases.

As seen above, the ages of these patients was about the same as those in which operation was done. In 2 cases the radical operation was advised and refused. Cystoscopy was performed in 13 cases and no vesical tumor was present in any case. There was no rectal ulcer present. It has been impossible to get an accurate reply in all cases as to the progress of catheter life. In 2 cases subsequent operations were required. Suprapubic cystotomy one, perineal prostatectomy one. In 10 cases the catheter life was said to be painful, difficult or very obnoxious, and often the catheter had to be used very frequently. In only 8 cases was the catheter life said to have been very satisfactory, and in 2 of these the patient said it was quite disagreeable. In other cases no reply could be obtained. In 18 cases the symptoms of the disease had been present less than one year, over one year 3 cases, two years 5 cases, three years 6 cases, four years 1 case, five years 2 cases, and six years 2 cases. Final notes have been received in regard to 28 patients. Five are still alive 2 years, 10 months, 6 months, 5 months, and 5 months since admission, and in these cases the disease has been present 5 years, 2 years, 2 years, 6 years, and 4 years.

Twenty-three patients are dead, the length of time they lived after seen by us being a month or less 6 cases, under six months 3 cases, under a year 6 cases, over a year 6 cases, two years 1 case, five years 1 case.

As seen in this tabulation of 23 cases, only 3 patients have lived two years or more since their first visit, so that it would seem that the duration of life after an incomplete prostatectomy was, as a rule, longer than if no operation was performed. Our statistics in regard to whether catheter life was satisfactory seem to show only about 6 in which it was very difficult or painful, but they are, I believe, far from accurate, and I believe if the truth were known we would find that in the majority of cases the use of a catheter is difficult: painful, often very frequent, and a great burden to the patient. It is sometimes only when freed of this burden by operation that the patient realizes what a load has been lifted. It is nevertheless true that in some cases a small straight soft rubber catheter has been employed for a long time with considerable satisfaction, and when the patient is able to use a catheter well it is my habit to advise that he continue this until it becomes a burden before suggesting a partial prostatectomy.

Cases in which Neither Operation Nor Catheter Life was Advised.—There were 29 which came under this category. These cases present an unusual and interesting group because of the lack of the usual severe obstruction to urination. In 19 cases a catheter had never been used, in 4 cases it had been only occasionally employed. In one case acute retention of urine was present on admission and in 4 cases the catheter was employed daily. Difficulty of urination was present in one case, in 8 cases the difficulty of urination was considerable, in 2 cases slight; the increased frequency was considerable in 11 cases, moderate in 4 and slight in 7 cases. Pain was the most prominent symptom in most cases and involved various regions from the chest to the feet. The course of the disease was rapid—under one year in 7 cases, moderately rapid (two to three years) in 14 cases; and slow in 7 cases.

CONDITION OF PROSTATE AND SEMINAL VESICLES.

	Prostate.	Seminal vesicles.	Intervesicular space.	Membranous urethra.
Size:				
Slight	8	5	5	..
Moderate	3	4	3	2
Considerable	17	14	13	10
Surface:				
Smooth	10	..	..	..
Rough	12	1	..	..
Consistence:				
Elastic	1	..	2	2
Slightly indurated	..	..	..	..
Moder't'y indurated	3	2	2	1
Hard	19	17	14	10
Stony	4	4	4	1
Soft and hard	2	..	..	..

As shown in the above tabulation the prostate and seminal vesicles were considerably enlarged in 50 per cent. of the cases, so the lack of urinary obstruction is not due to the absence of prostatic enlargement. Among these 29 cases we have been unable to obtain answers in regard to the future course of the disease in 8. Among the 21 cases from whom replies have been obtained in only 5 did catheterization become necessary and in 3 of these subsequent operations were necessary (two suprapubic drainage and one perineal prostatectomy with relief from catheter life). Among the 21 patients that have been heard from, 7 are still alive, 3 of them six months, 3 between six and eleven months, and 1 one year after being seen by us. In these 7 cases the patient has lived 5, 4, 3, and 2 years, 9, 9, and 7 months since the beginning of symptoms. Fourteen patients have died since our examination, having lived less than six months 4 cases, between six and eleven months, 2 cases; one year, 1 case; two years, 5 cases, and three years, 2 cases. The total length of time these patients lived after beginning of symptoms was under six months 1, under one year 1, over one year 1, two years 4, three years 3, four years 1, five years 1, eight years 1, ten years 1.

This class of cases therefore is remarkable for the length of time in which the disease persisted and the extent of the involvement and the freedom from marked urinary obstruction. They represent a class of cases in which early diagnosis is difficult unless rectal examination be made before the beginning of obstructive symptoms and for merely slight pain and discomfort in the various regions from the chest down which are shown to be reflexly involved by carcinoma of the prostate. The presence of an indurated prostate in any such case should lead to careful investigation and probably exploratory operation. These cases show the great importance of rectal examinations as a routine in physical examinations.

CONCLUSIONS.

The following conclusions may be drawn from this study of 111 cases:

Carcinoma of the prostate is more frequent than usually supposed—occurring in about 20 per cent. of the cases of prostatic enlargement. In 500 cases of prostatic obstruction 100 were carcinomatous, and 400 were benign hypertrophies.

It generally causes the same symptoms as prostatic hypertrophy; but later pain, local and referred, and often simulating other diseases—renal, spinal, sciatic—and neuralgic is often a very prominent symptom.

It may begin as a small nodule in an otherwise healthy prostate, or where a chronic prostatitis is present. A case of hypertrophy may become the seat of cancer, but almost always in a non-hypertrophied portion, generally in the posterior subcapsular stratum behind the hypertrophied lateral lobes.

Cancer of the prostate remains for a long time within the confines of the lobes, the urethra, bladder and especially the posterior capsule of the prostate resting inviolate for a considerable period. Extraprostatic invasion nearly always occurs first along the ejaculatory ducts into the space immediately above the prostate between the seminal vesicles and the bladder and beneath the fascia of Denonvilliers. Thence the disease gradually invades the inferior surface of the trigone, and the lymphatics leading toward the lateral walls of the pelvis; but involvement of the pelvic glands occurs late, and often the disease metastasies into the osseous system without first invading the glands.

Examination of the prostate and seminal vesicles should be included as a routine procedure in physical examinations, and when marked induration, if only a nodule in one of the lobes of the prostate is found in a man past 45 years of age, it should be viewed with suspicion, especially if there is no history of long standing prostatitis, and if the cystoscope shows no intravescal hypertrophied lobes.

In such cases, although few symptoms may be present, an exploratory operation should usually be advised, and if the operator is unable to make a positive diagnosis as to malignancy by the aspect of the posterior surface of the prostate, exposed through the perineum, longitudinal incisions should be made and tissue excised for examination and stained frozen sections made if necessary. If the disease is malignant the incisions may be cauterized and the radical operation performed.

Cure can be expected only by the routine removal of the seminal vesicles, vasa deferentia and anterior two-thirds of the vesical trigone with the entire prostate. The operation is not extremely difficult nor dangerous, and already at least one cure has probably been obtained (now almost five years since operation).

When the disease is advanced and urination very difficult and frequent a catheter life should be adopted. When, however, catheterization is difficult or painful a palliative operation should be done, in some cases suprapubic cystostomy, but excellent lasting relief of urinary obstruction and vesical pain can be secured by careful conservative perineal prostatectomy.

ACUTE HÆMORRHAGIC PANCREATITIS.

REPORT OF A CASE SUBJECTED TO OPERATION TERMINATING IN RECOVERY.

BY JAMES R. JUDD, M.D.,
OF HONOLULU, HAWAII.

Mrs. M., 28 years of age, German, was seen at the Queen's Hospital, August 26, 1908, in consultation with Dr. W. L. Moore. The following history was obtained: Four years ago she suffered from a severe attack of "indigestion" lasting for four days. The attack was characterized by vomiting, constipation and severe pain in the upper abdomen. Six months ago while in New York City, she had an attack of renal colic followed by the passage of several small stones. She had been troubled with constipation for years and was in the habit of taking pills.

Present History: The day previous to her admission to the hospital she had eaten a hearty supper, consisting of fried pork chops, and in the morning had taken some aperient pills and had followed with some fruit salts. Shortly afterwards severe, knife-like pain commenced in the epigastrium, and the patient was so prostrated that she could hardly get to bed. Vomiting then began and persisted. The pain tended towards paroxysmal, was increased on movement and was only partly relieved by anodynes and heat to the abdomen. There was considerable prostration, which was combated by hypodermic stimulation and heat. The bowels had not moved, although several enemata containing ox-gall and turpentine had been given. The patient was then moved to the hospital and was seen by me about thirty hours after the onset of the attack.

Physical Examination: This showed a small woman of 106 pounds, with facial expression of prostration and suffering. The patient lay with her knees drawn up and complained bitterly of the pain in the epigastrium. Temperature 99.4; pulse 90, small and feeble; respiration 26. There was no jaundice. Heart and lungs negative. The abdomen was somewhat distended. There was considerable muscular rigidity and tenderness on palpation, most marked to the right of the umbilicus. The percussion note was tympanitic with slight dulness in the flank and liver dulness not obliterated. Pelvic examination was negative. Vomitus consisted of dark bilious fluid mixed with mucus.

Urinalysis: Yellow, acid, 1.024, no albumin or sugar. Microscopical examination negative. Cammidge test was not attempted. Leucocyte count showed 25,000 white cells. No differential count was made.

Immediate laparotomy was advised and undertaken.

Operation: Anæsthetic, chloroform. In order to insure that the appendix was not at fault, incision was made over that organ. On incising the peritoneum considerable blood-stained fluid was met with and the peritoneum, both parietal and visceral, was acutely inflamed. The appendix showed the gross evidences of a chronic inflammatory process plus the general congestion, and was removed. This incision was then closed and an epigastric incision in the middle line was made. Blood-stained fluid and inflamed peritoneum were encountered. The gastrohepatic omentum showed the characteristic areas of fat necrosis resembling spots of candle grease. The lesser omentum was very friable and was easily torn through. This disclosed the lesser sac partially filled with bloody serum, and the pancreas enlarged, swollen, soft and purplish in color. An opening was made into the head of the pancreas with a blunt instrument and a cigarette drain inserted leading out above the stomach through the gastrohepatic omentum. The gall-bladder and ducts showed no stones and were apparently in normal condition. The wound was then closed, except for the space occupied by the drain, and another drain inserted through a suprapubic stab wound. The patient was put to bed with the head of the bed raised and was given normal saline solution per rectum. Steady improvement followed the operation. There was considerable drainage of a thin, bloody fluid for the first twenty-four hours, which rapidly diminished and by the third day drainage had practically ceased. The temperature reached 101.4 on the second day, and was elevated one to two degrees for twelve days, after which time it remained normal. The pain continued, although of less intensity, for three days and required several hypodermics of morphine. The bowels moved voluntarily on the fourth day, followed by a profuse diarrhœa for several days. Convalescence was then uneventful and the patient returned home during the fourth week. Since the operation, nine months ago, she has enjoyed good health and at the present time is in splendid condition.

Considering briefly the etiology, gall-stones and septicæmic infections being excluded, infection from the duodenum would seem to be the most likely etiological factor. Whether any credit may be given to a poorly digested quantity of pork chops, followed by a number of cathartic pills, is open to doubt.

According to the patient, the previous attack four years ago was similar in its symptoms, except in their severity. This brings up the question of the responsibility of small hemorrhages occurring in the gland, with spontaneous recovery and not recognized as such.

The characteristic description as given by Fitz in 1889, and not improved upon since, is a valuable one to have in mind. " Sudden, severe, often intense epigastric pain without obvious cause, in most cases followed by nausea, vomiting, sensitiveness and tympanitic swelling of the epigastrium. There is prostration, often extreme, frequent collapse, low fever and a feeble pulse."

The question as to whether the hemorrhage precedes the inflammation, or whether the inflammation precedes the hemorrhage, could not be settled in this case. According to the descriptions as set forth in Mayo Robson's admirable work, entitled "The Pancreas: Its Surgery and Pathology," the case may be regarded as of the ultra-acute variety, in which the hemorrhage precedes the inflammation.

Cyanosis of the face and a general lividity of the skin noted by Halsted, Jacobson, Moynihan and others was not present in this case.

The condition being such a rare one, the diagnosis will seldom be made on the surgeon's first case. The persistent vomiting and constipation suggested intestinal obstruction, but the severity of the pain and the lack of any fecal odor were against it. Perforation of a gastric or duodenal ulcer was discredited by the lack of any preliminary history indicating such a condition. The presence of liver dulness was also against it. Perforative appendicitis was suspected, as the point of greatest tenderness was to the right of the umbilicus, but the excruciating pain and absolute constipation were arguments against it.

The important point in treatment is, as Moynihan succintly says, " the surgeon will feel that some acute catastrophe has occurred in the abdomen and that in operation alone lies the hope of relief."

The mortality is high. According to Mikulicz's much quoted statistics (ANNALS OF SURGERY, May, 1903), there were on record 75 operations for acute pancreatitis, with 29 deaths. Later compiled statistics will probably show a larger percentage of recoveries.

PANCREATO-ENTEROSTOMY AND PANCREATECTOMY.

A PRELIMINARY REPORT.

BY ROBERT C. COFFEY, M.D.,
OF PORTLAND, OREGON.

Food is prepared for appropriation almost exclusively by derivatives of the primitive foregut (the stomach, liver and pancreas). The upper portion of the primitive foregut lies between the layers of the partition of the primitive body cavity which extends anteroposteriorly. That portion of the partition in front of the foregut is called anterior mesogastrium, while that lying behind the primitive foregut is called posterior mesogastrium. Early in fetal life a bud projects off from the primitive tract between the layers of the anterior mesogastrium and forms the liver and bile tracts. Another bud which is supplemented by a secondary one, projects from the primitive alimentary tract backwards between the layers of the posterior mesogastrium, and after blending form the pancreas and pancreatic ducts, the chief of which empties into the alimentary canal through a common opening with the liver duct. The stomach, representing the upper expanded portion of the primitive foregut, always remains between these two layers of membrane which becomes peritoneum, therefore is surrounded on all sides by a peritoneal coat. The liver with gall-bladder develops between the layers of the anterior mesogastrium and therefore is always covered with peritoneum. During the process of intestinal rotation which occurs in fetal development, the pancreas and second and third portions of the duodenum are thrown out of the peritoneal cavity.

As surgery becomes a more definite science we are learning that the peritoneum is an essential in almost all abdominal surgery, and in addition to forming a smooth covering and strong support it has another function equally important: namely, that it throws out exudate when injured, which serves a purpose similar to the callus thrown out in the repair of broken bone. This exudate penetrates the adjacent tissues for some distance around. In the course of a few days the exudate or "callus" becomes organized. The bulk of the exudate is soon absorbed, leaving the firmer elements, so that the repair is soon complete and the broken surface covered by a new and smooth peritoneum.

The gall-bladder, which is a part of the hepatic structure ordinarily used for surgical purposes because of its convenience and peritoneal covering, and the stomach, have been conquered by the surgeon and brought into the actual and legitimate domain of surgery, while the pancreas remains technically almost a stranger to the surgeon. Many reasons have been given for this, but to the mind of the writer the one most plausible is based on the premise that the fundamental defect in the pancreas, as far as surgical work is concerned, is that it is devoid of peritoneum, and it was with this principle in view that experiments were begun some months ago.

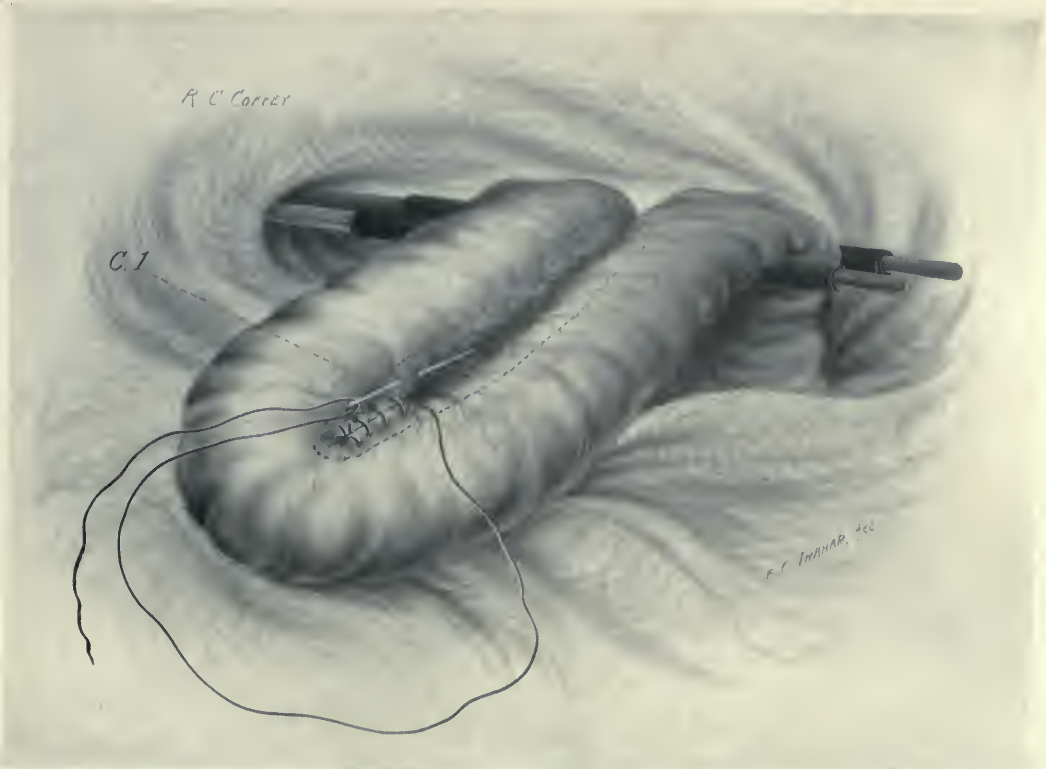
The fat-splitting ferment of the pancreatic juice has been the terror of surgeons up to date, but in a close study of results which have been obtained by experimenters, we fail to find any positive evidence that even pancreatic juice will penetrate peritoneum to a serious extent. The fat-splitting ferment seems to travel in the planes of the areolar connective tissues, outside the peritoneum; therefore it proves serious because of the anatomical position of the pancreas, but not so serious as the contents of the intestinal canal would be by escaping in the same neighborhood. So it seems that the principal danger of pancreatic juice in surgery is not that it is so virulent itself, but because it escapes into the retroperitoneal fat. Consequently, the principal problem was to provide unbroken peritoneum with which to surround the part of the pancreas participating in the formation of the operative field. Two methods were considered as being applicable to the situation. First, implantation of the cut end of the remaining pancreas into the intestine, using the peritoneum of the intestinal wall to make the union. Second, a direct implantation of the duct into the intestinal wall and fastening a collar of omentum around the duct and pancreas at the point of intended union. The first method seemed much the better and was used exclusively in the first series of operations reported below. The first attempt was to implant the cut end of the pancreas into the side of the intestine, which proved to be impractical. The next thought was to invert a cut end of the intestine and implant it there. This was done in two instances, but the post-mortem showed that the end was too small, as it constricted the end of the pancreas, causing its death. (There might, however, be conditions in which this would be a suitable method, in which cases it would be ideal.) After considering the anatomy of the intestine it was thought feasible to throw the lumen of two intestines into one by using a loop and thus give ample room for implanting the pancreas. The perfected technic resulting from the experiences of the two series of operations reported below, and which is recommended for use, is illustrated by Figs. 1 to 12 and may be described as follows:

First, pick up a loop of intestine, preferably jejunum, using care that mesentery at the point is long enough to reach the pancreas with ease. Clamp both arms of the loop with a rubber-covered stomach clamp, leaving the loop three or four inches long. Suture the intestines together with continuous Lembert suture near the mesenteric edge to a point near the clamp. Grasp the thread with a forceps at this point and hold till all other steps of the operation are complete (Fig. 1, *C*. 1).

Second, with knife or scissors open the intestine around the loop (Fig. 2), (indicated by dotted line in Fig. 1) one-fourth inch from line of suture, thus cutting the two intestines into one.

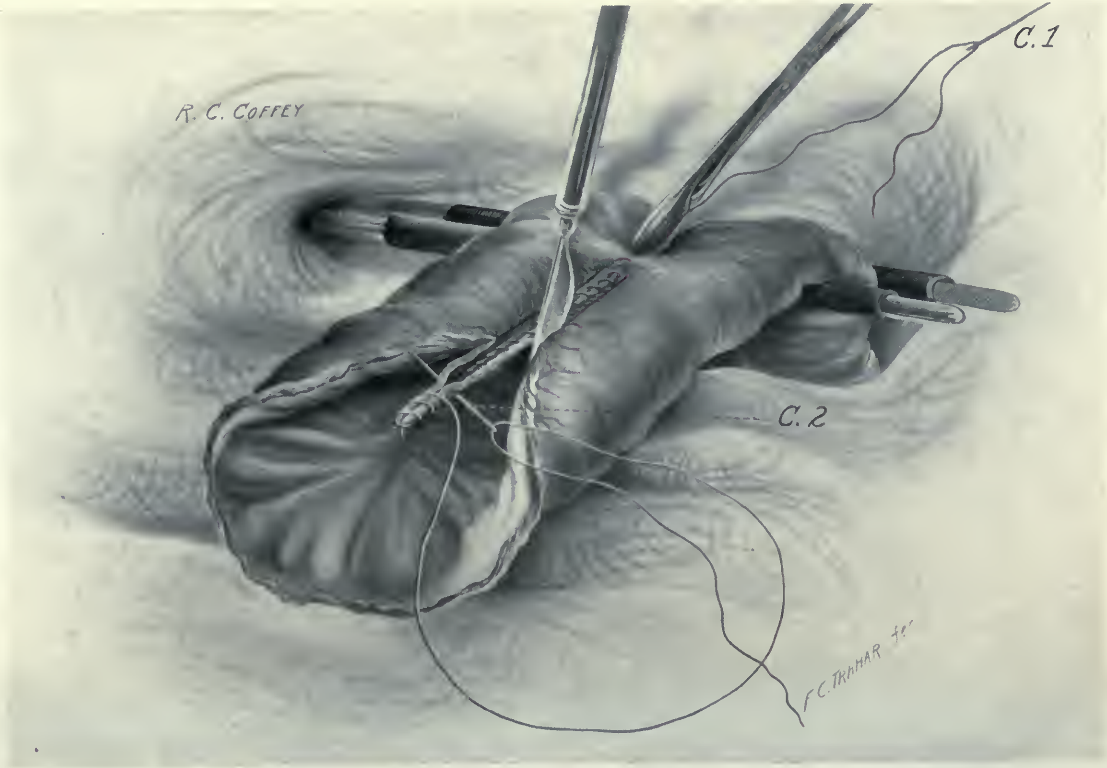
Third, with through-and-through continuous suture beginning inside (Fig. 2, *C*. 2) and continuing around (Fig. 3, *C*. 2) close the loop, leaving but a single lumen. Stop when the end resembles the cut end of a single intestine, and tie knot,

Fig. 1.



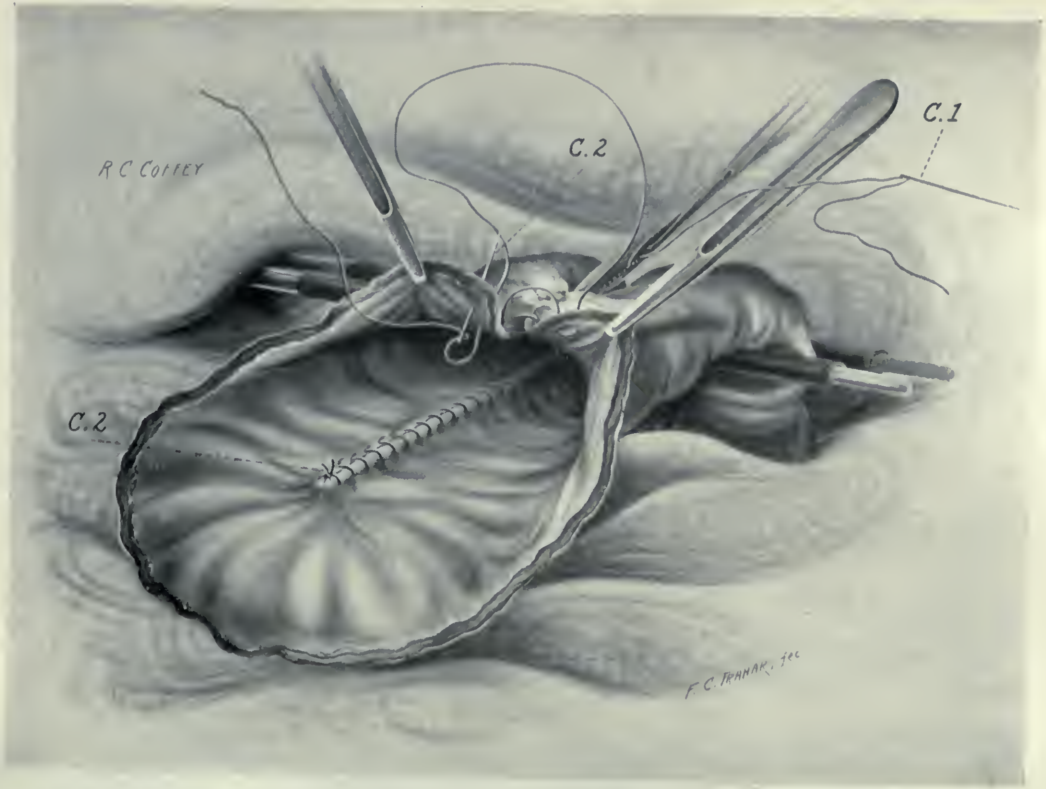
Suturing arms of intestinal loop together with primary continuous Lembert suture, *C* 1. (dotted line indicates where incision is to be made).

FIG. 2



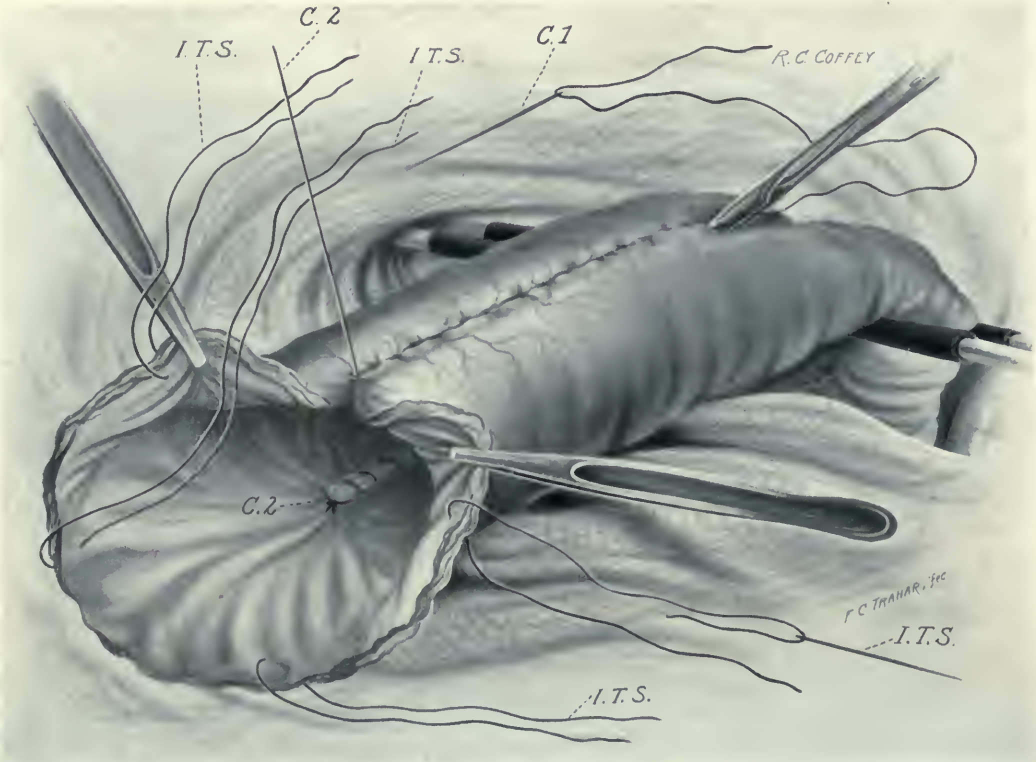
Opening intestinal loop and beginning the through-and-through suture, *C* 2. *C* 1, primary continuous Lembert suture.

FIG. 3.



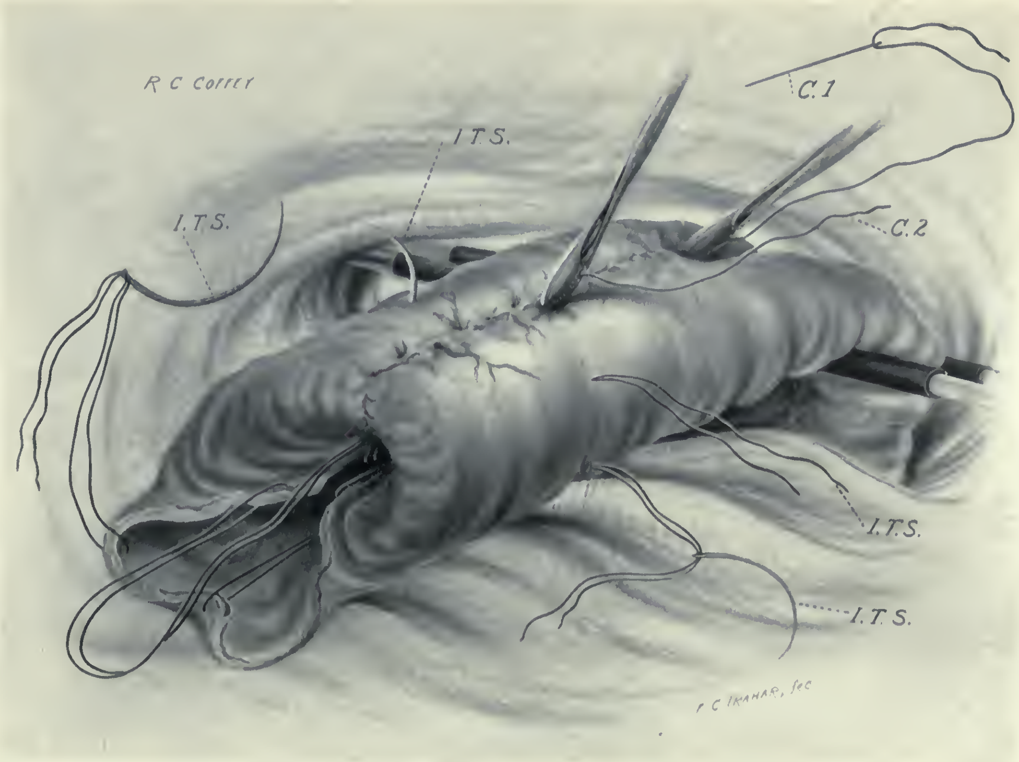
Converting two arms of intestinal loop into a single lumen by continuation of through-and-through suture, *C* 2. *C* 1, primary continuous Lembert suture.

Fig. 4.



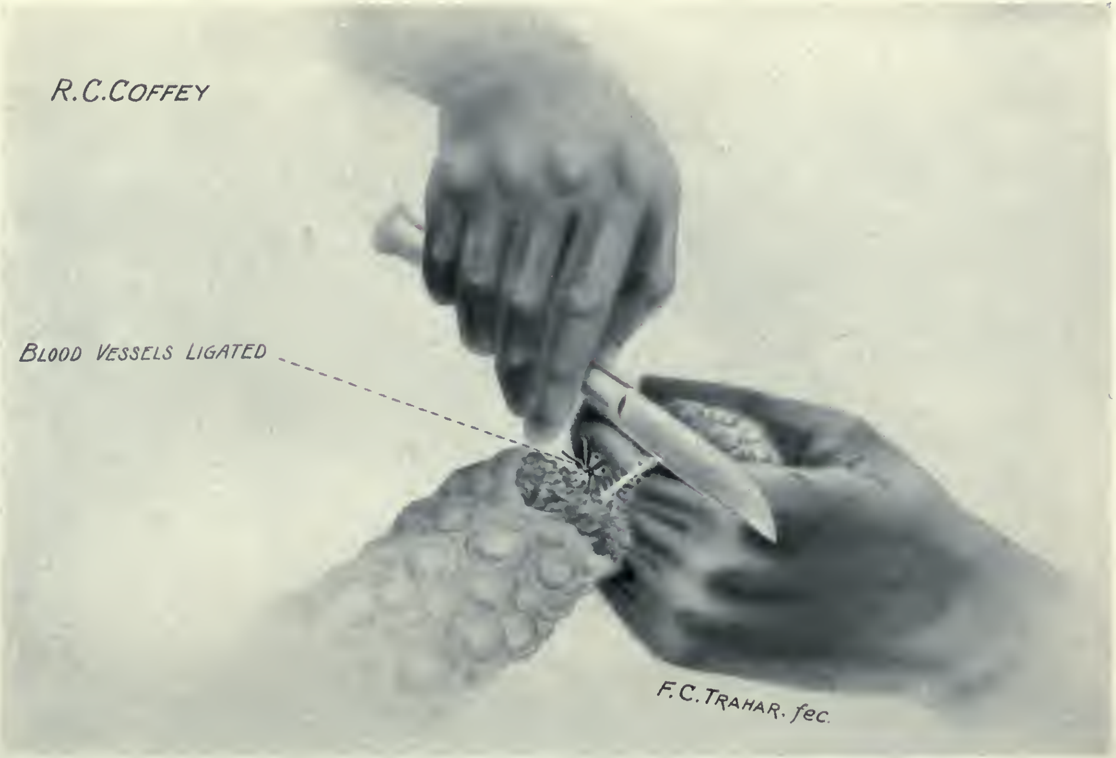
Placing intestinal traction sutures, *I.T.S.* *C* 1, primary continuous Lembert suture. *C* 2, beginning and end of through-and-through suture.

Fig. 5.



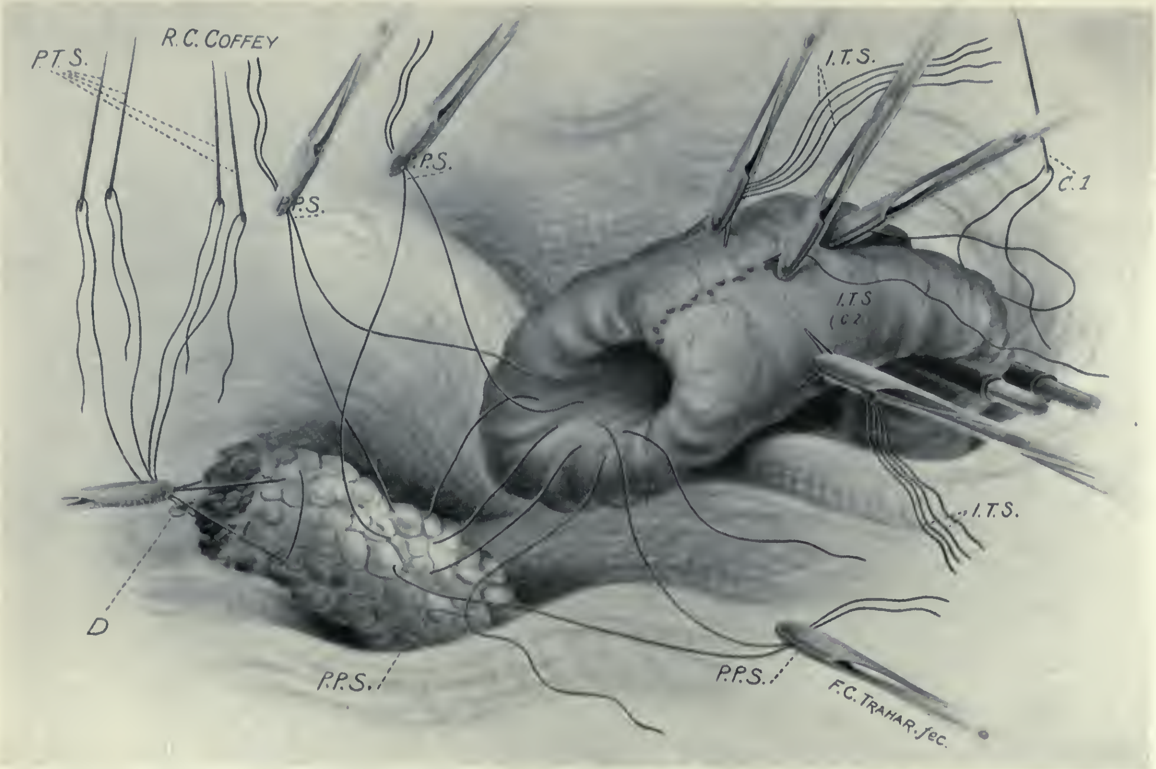
Passing intestinal traction sutures (*I.T.S.*) into the lumen and out through the wall of the intestine. *C* 1, primary continuous Lembert suture. *C* 2, through-and-through suture used for traction.

Fig. 6.



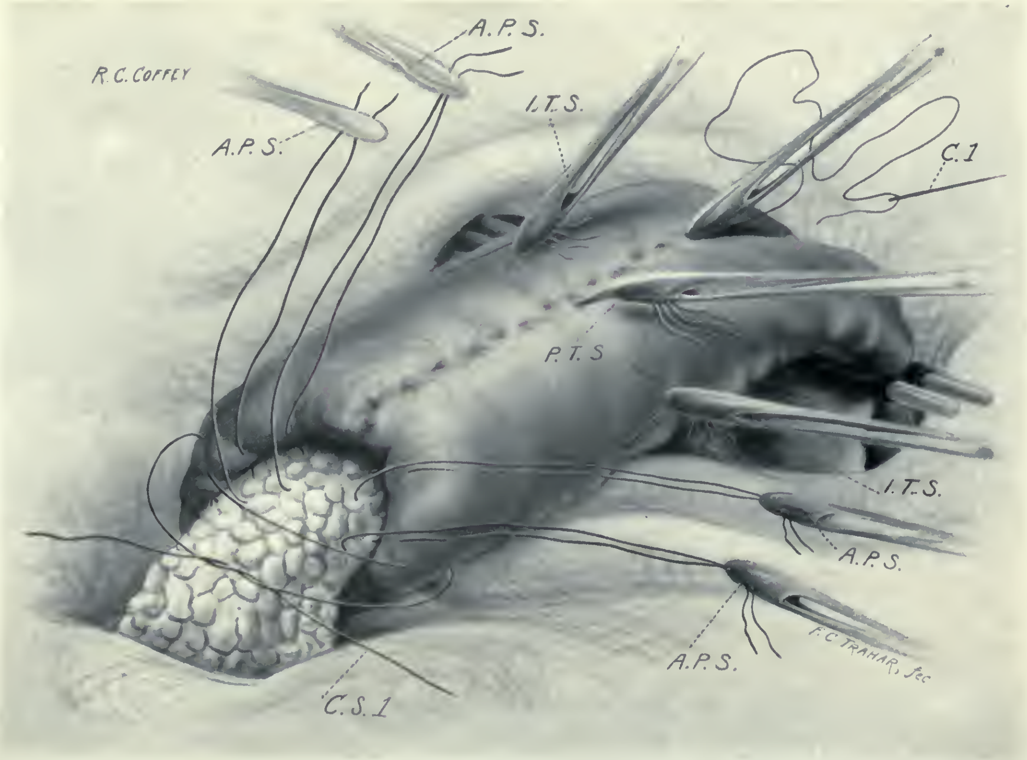
Stripping pancreatic substance from the duct.

FIG. 7.



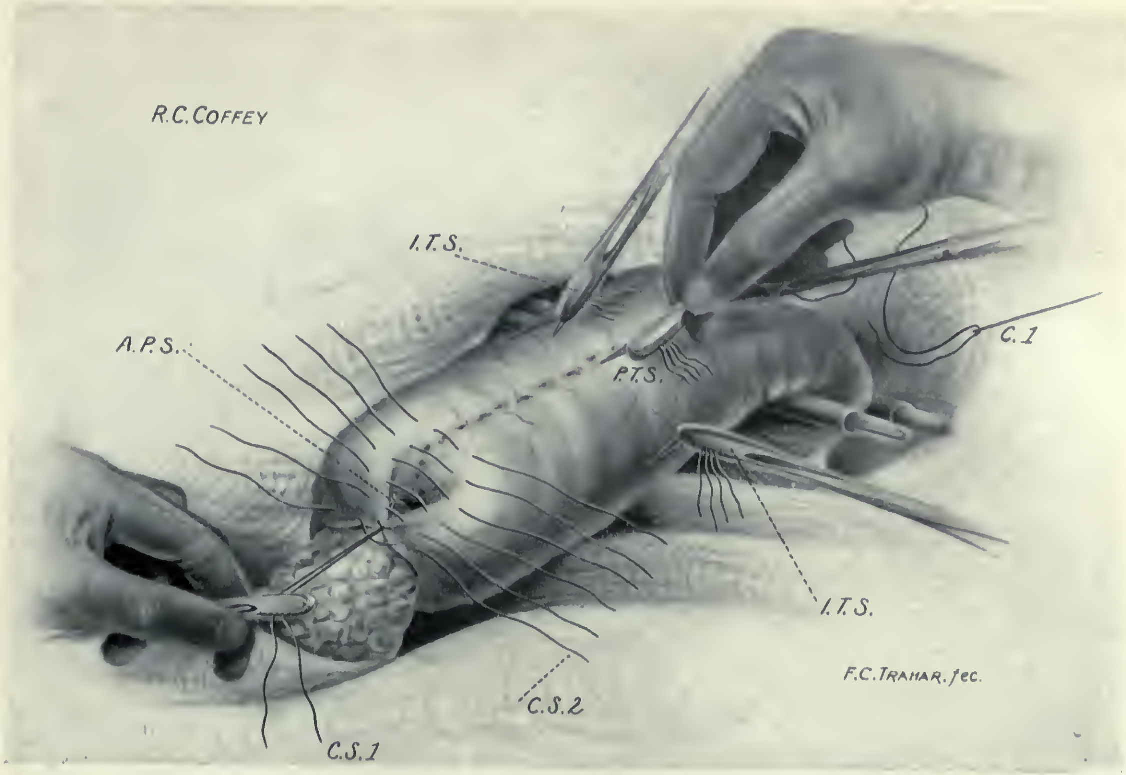
Preparing to introduce cut end of pancreas into lumen of inverted gut. *P.T.S.*, Pancreatic traction sutures which are to be threaded into a single needle and passed into the lumen and out through the wall of the intestine. *P.P.S.*, Posterior pancreatic sutures passed through the intestine and pancreas and left loose until cut end of pancreas is drawn into place. *I.T.S.*, Intestinal traction sutures maintaining inversion. *C.* 1, Primary continuous Lembert suture. *D.*, Duct.

Fig. 8.



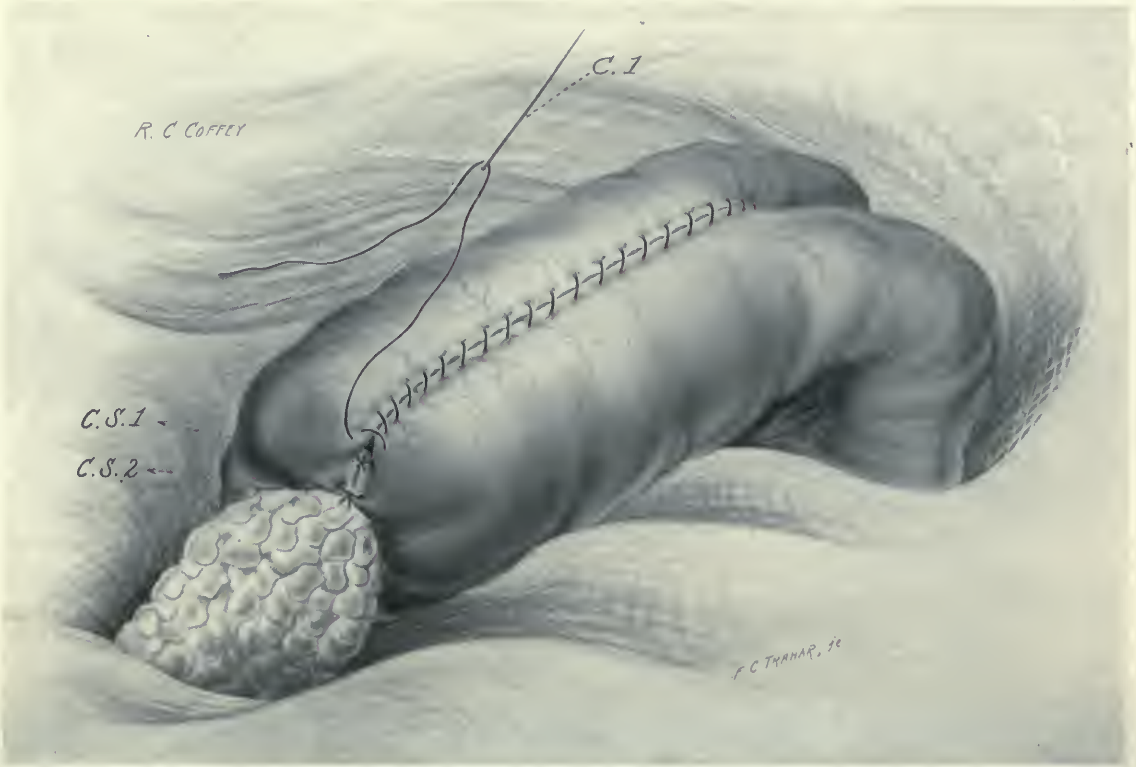
Placing anterior pancreatic sutures which are to be covered by tying the collar suture. *A.P.S.*, anterior pancreatic sutures. *C.S.* 1., collar suture one. *I.T.S.*, intestinal traction suture maintaining inversion. *P.T.S.*, pancreatic traction sutures maintaining the position of the pancreas. *C.* 1, continuous primary Lembert suture.

FIG. 9.



Completing the collar of intestine around the pancreas, the anterior pancreatic sutures having been tied, *A.P.S.* Hands indicate traction and counter traction on the collar suture 1, and pancreatic traction sutures while other sutures are being placed. *I.T.S.*, Intestinal traction sutures. *P.T.S.*, Pancreatic traction sutures. *C.S.* 1, Collar suture one. *C.S.* 2, Collar suture 2. *C.* 1, Continuous primary Lembert suture.

Fig. 10.



Completing operation with the primary continuous Lembert suture.

leaving the suture long (Fig. 4) to be used later as a traction or inversion suture (Fig. 5).

Fourth, pass four or more traction or inversion loops through the edge of the intestine (Fig. 4).

Fifth thread the two ends of each traction suture, also the single end of *C.* 2, through large eyed needles, and pass them into the lumen and out through the wall of the intestine one and one-half to two inches back of the cut edge (Fig. 5). By pulling on these sutures the intestine is perfectly inverted when the traction sutures are caught by forceps to maintain inversion, and thus keep a clean field (Fig. 7), while the operation progresses.

Sixth, with the back of a scalpel, strip the pancreatic tissue from the duct and vessels, ligate the vessels, split the duct and cut it so as to leave one quarter to one half an inch protruding beyond the pancreatic tissue (Figs. 6 and 7).

Seventh, complete the required operation on the pancreas and pass a quilt suture (using a needle on each end of the thread preferably) from each side of the pancreas at a point near the end to be implanted. These sutures are to be used as traction sutures in pulling the pancreas into the lumen of the inverted gut (Fig. 7). Owing to the friability and the seriousness of tearing it during the operation it is necessary to avoid traction on the sutures which are to fasten the pancreas to the peritoneum of the intestine. Therefore it is well to pass four or more sutures, which include a bite of the pancreas and a corresponding bite of the intestine, grasping both ends of each suture with forceps as it is placed, to avoid entanglement (Fig. 7). These sutures are designated posterior pancreatic sutures (*P. P. S.*). Now thread all the pancreatic traction sutures into a large-eyed needle and pass the needle into the lumen well above the inverted edge and out through the intestinal wall near the line of sutures so the final continuous Lembert suture (*C.* 1) will cover the hole. By traction on these sutures draw the end of the pancreas into the lumen until the corresponding points of the pancreas and intestine which are caught by the posterior pancreatic suture

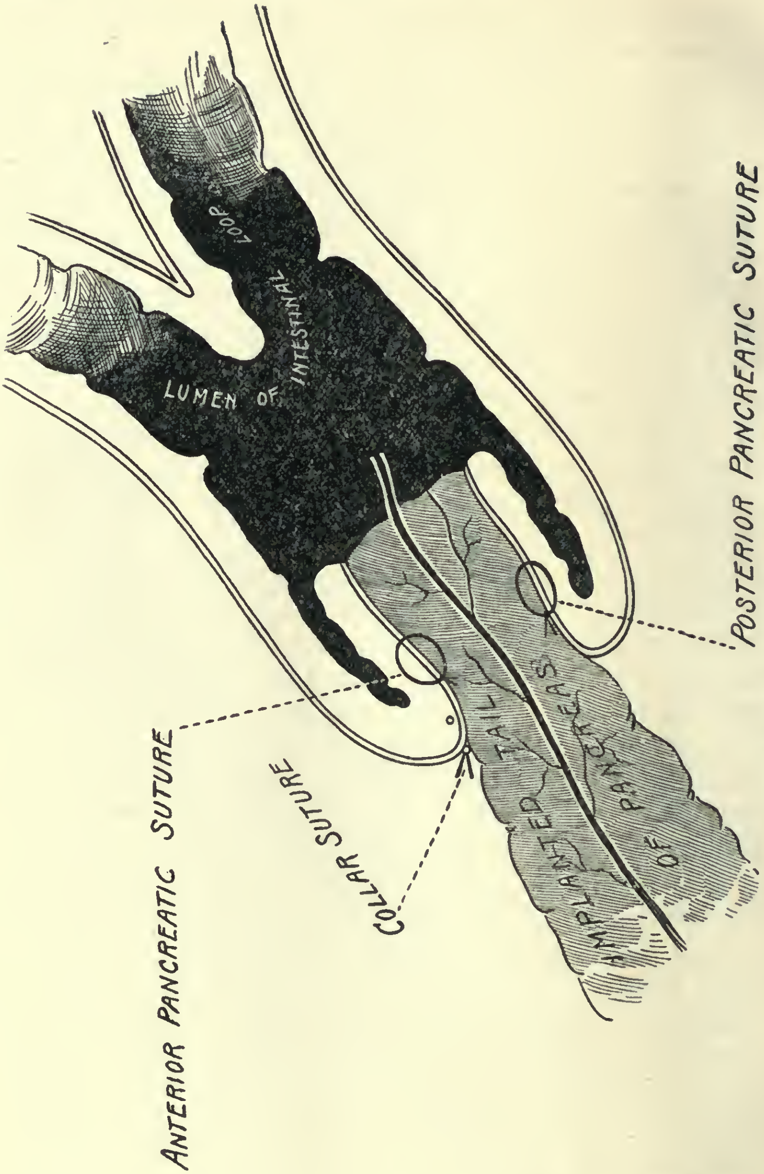

LUMEN OF INTESTINAL LOOP
IMPLANTED TAIL OF PANCREAS
ANTERIOR PANCREATIC SUTURE
COLLAR SUTURE
POSTERIOR PANCREATIC SUTURE

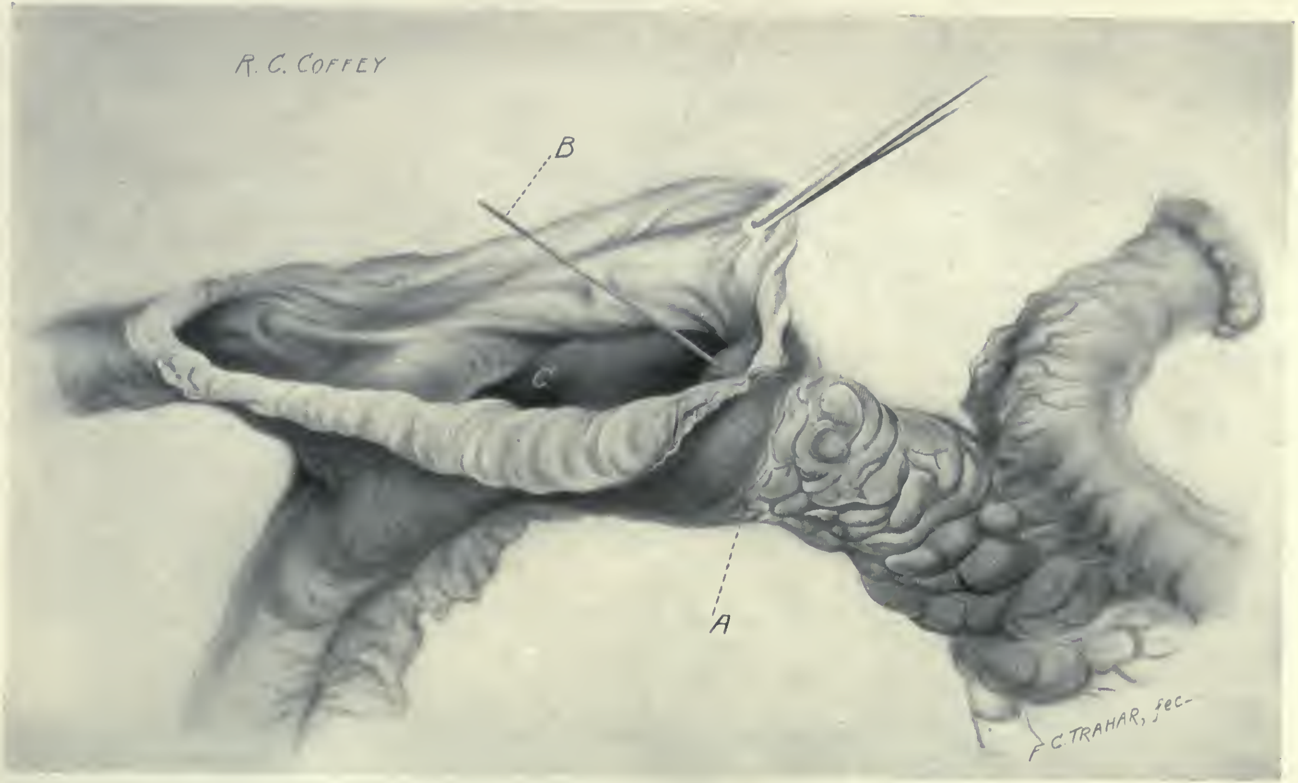
FIG. 11.

Sectional view of pancreato-enterostomy as described.

are in contact, when the sutures are gently, but firmly tied and cut.

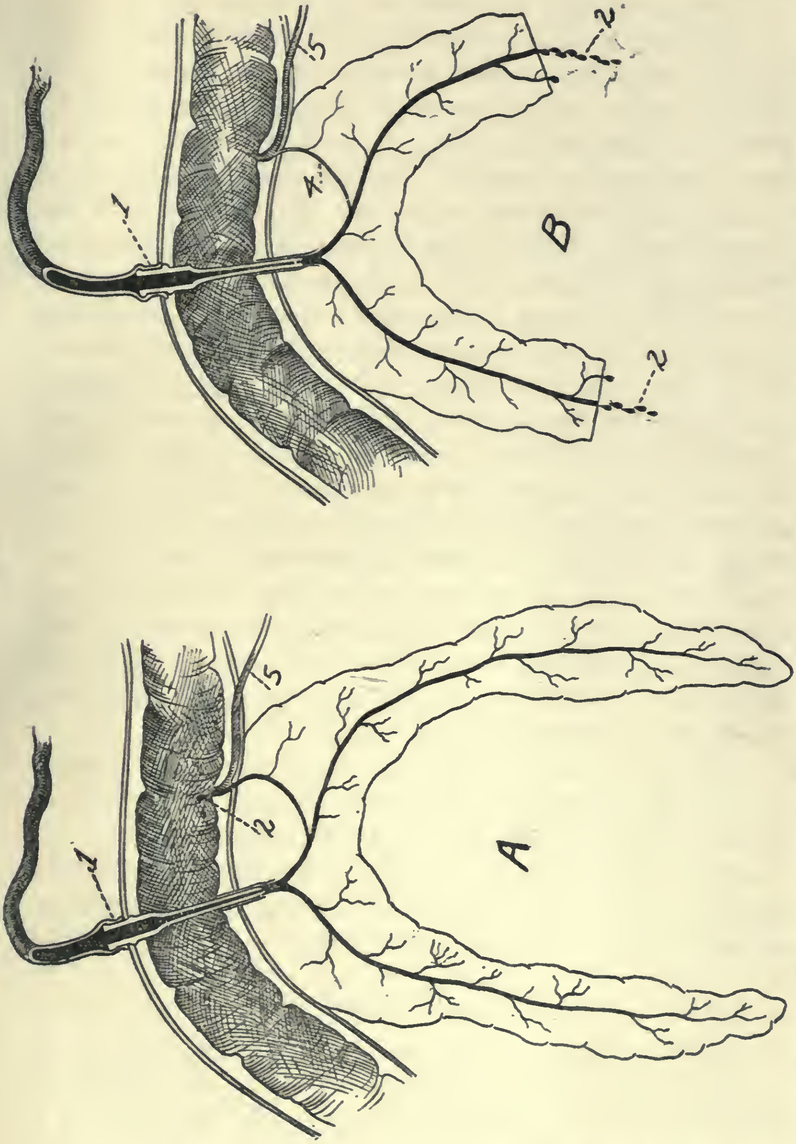
Eighth, pass four or more anterior pancreatic sutures

Fig. 12.



Drawing from fresh specimen removed from dog five weeks after operation, showing result of pancreato-enterostomy. *A*, line of union between pancreas and intestine. *B*, probe in open end of pancreatic duct. *C*, intestinal lumen through the loop.

FIG. 13.



Anatomical diagram illustrating relations of ducts in a dog's pancreas. *A* 1 and *B* 1, Nozzle carrying methylene blue solution into the duct of Wirsung and filling pancreatic duct. *A* 2, Drops of fluid forced out through the duct of Santorini under pressure. *B* 2, Drops of fluid dripping from ducts of both pancreatic tails. *B* 4, Duct of Santorini. *A* 5 and 5B, Bile duct.

including a bite of pancreas and intestine (Fig. 8, *A. P. S.*) in such a manner that the sutures will form a circular row continuing the posterior pancreatic sutures. Grasp the two ends of each suture with a forceps as soon as it is passed.

Ninth, pick up the intestine on each side of the pancreas with a suture at such a distance as will permit it to be drawn loosely around the pancreas in the form of a collar. Make counter traction on the pancreatic traction sutures (*P. T. S.*) while the collar suture (Fig. 8, *C. S.* 1) is being drawn below the pancreatic sutures. The anterior pancreatic sutures (*A. P. S.*) should now be tied within the collar suture before the collar suture *C. S.* 1, Fig. 8 is completely tied. A second collar suture (Fig. 8, *C. S.* 2) is placed below this one at points which will draw the intestine snugly enough to prevent leakage, but not tight enough to constrict the circulation or duct. This point, of course must be left to the personal equation of the operator. After these sutures are tied, two or three more sutures are used to close this space. While these remaining sutures are being placed, an assistant makes traction on the collar suture with one hand, and on the pancreatic sutures with the other, to avoid tension on the pancreatic sutures till the operation is completed (Fig. 9). Thus both the anterior and posterior pancreatic sutures are included within the peritoneal collar which has been placed around the pancreas. All traction sutures are now cut short and allowed to drop back into the intestine.

Tenth, continue the primary Lembert suture (*C.* 1), which has been held in the forceps during the operation, around to the pancreas, covering all previous sutures (Fig. 10).

Eleventh, as an additional safeguard (which is possibly an unnecessary refinement), we have wrapped omentum around the point of union and stitched it there.

FIRST SERIES OF EXPERIMENTS.

Our work has all been done on dogs—the dog's bile tracts are practically the same as in man. The pancreas, instead of being a long straight organ, is arranged in the shape of a horseshoe, from which a tail extends back of the stomach to the hilus of the spleen, thus corresponding to the human pancreas. For want of a better name, we have designated this the retrogastric tail. The other tail follows the concavity of the duodenum, lying loosely between the peritoneal folds of the mesentery. In operating on this tail it is necessary to strip off these layers of peritoneum from the pancreas in order to make it conform to the human pancreas, which is largely extraperitoneal. The ducts of the two tails meet at the toe of the horseshoe to form the duct of Wirsung, which is from one-fourth to three-fourths inch in length and empties into the duodenum one to two inches below the opening of the bile duct. The duct of Santorini usually has a common opening with the bile duct. This duct has been present in all of our dogs and seems to drain an area of the pancreas more or less independent of the greater pancreatic duct, but one or more of its branches connect it directly with the greater duct. The connection seems to be much the same as a canal used to connect the branches of two rivers which flow in opposite directions from the top of a watershed. If a nozzle attached to a fountain syringe filled with methylene blue solution is tied in the duct of Wirsung and the fluid allowed to run, the pancreas rapidly becomes stained throughout, but is a more faint blue toward the surface. If the pressure is considerable, the fluid after a time finds its way through the duct of Santorini (Fig. 13, *A*). If the ends of the tail are cut off the fluid flows out without apparent resistance and does not pass through the duct of Santorini (Fig. 13, *B*). If the duct of Wirsung is ligated, and if the pancreatic tissue is scraped off from the duct of one tail, and if the tip of the other tail is cut off, fluid introduced into the bared duct of the one tail easily (Fig. 13, *B*) passes around and out at the end of the other tail, and sometimes, in this experiment, the fluid flows through the duct of Santorini simultaneously with the flow through the cut tail, while at other times it does not, but in all cases will begin to flow through the duct of Santorini if the open end of the cut duct is held with forceps. These experiments hold good in both living and dead animals.

If the tail is implanted into a loop of intestine by the method we have just described, and if both arms of the loop are clamped below, so as to shut the loop off from the intestinal canal, fluid introduced into the duct of Wirsung flows through the duct of the implanted end and distends the loop, without leaking at the point of anastomosis (Fig. 14, *B*).

Fig. 14.

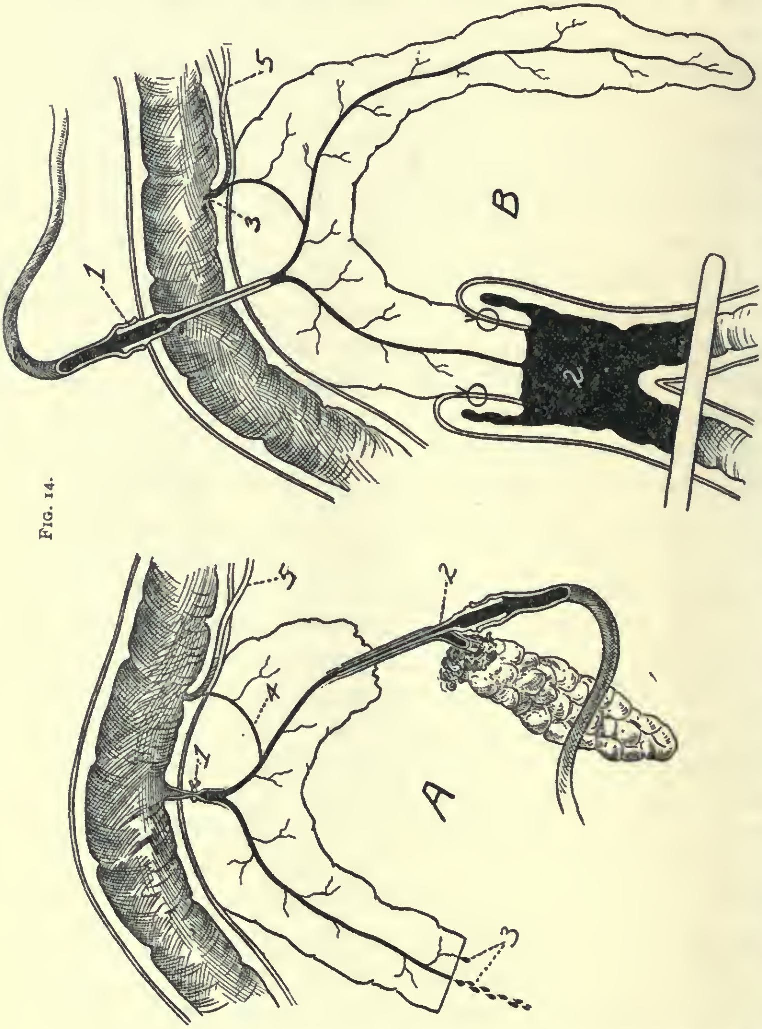


Diagram illustrating the surgical anatomy of a dog's pancreatic ducts. *A* 1, Duct of Wirsung, ligated. *A* 2, Nozzle carrying methylene blue solution inserted into duct of retrogastric tail of pancreas. *A* 3, Fluid dropping out of ducts of cut end of duodenal tail. *A* 4, Fluid in duct of Santorini not delivered into intestine until duct of duodenal tail is clamped. *B* 1, Nozzle carrying methylene blue solution into the duct of Wirsung. *B* 2, Intestinal loop distended with methylene blue solution after pancreatio-enterostomy. *B* 3, Drops of fluid forced out through the duct of Santorini under pressure from distended intestinal loop. *A* 5 and *B* 5, Bile duct.

Thus, by the foregoing study, we demonstrate the anatomical possibility of the following procedures: First, the surgeon can in cases of either malignant or non-malignant obstruction at the outlet of the pancreatic duct or in the duodenum, remove the head of the pancreas and implant the cut end of the remaining portion into a loop of intestine,—which operation would exactly correspond to the removal of the lower end of the bile duct for similar obstructions, with implantation of the remaining cut end into the intestine at another point; and would also correspond to the removal of the pylorus with anastomosis of the remainder of the stomach with the intestine lower down for similar obstruction: Secondly, in obstructions from whatever cause at the mouth of the pancreatic duct or in the duodenum which are not to be removed, the pancreas can be drained by implanting the cut end of the tail into a loop of intestine below, which would cause the pancreatic fluid to flow backward in the ducts. This operation would be exactly parallel to cholecystenterostomy for low obstruction in the common bile duct and to gastroenterostomy for obstruction at or near the pylorus. (Dr. W. J. Mayo in a personal communication has suggested this application of pancreato-enterostomy for clinical use.)

The next question to be solved is: Will these problems work out clinically as well as they do mechanically and anatomically.

From May 15 to July 28, 1909, forty operations were done on dogs with the view to answering this question. Twenty-four of these operations had for their essential feature pancreato-enterostomy, as described above. Three varieties of operations were performed. First: the duodenal tail of the pancreas was stripped of its peritoneum and cut in two and each cut end was implanted into a separate loop of the jejunum (Fig. 15 and 16). Second: the tail was cut off and implantation was made as in class one, but in addition the duct of Wirsung was ligated close to the intestine. Third: pancreatectomy was done in two stages, as follows:

First operation: The common bile duct was transplanted to the duodenum lower down, gastrojejunostomy was performed and the stomach was cut off and ends turned in just above pylorus (Fig. 17).

Second operation, or second stage of operation: The body and duodenal tail of the pancreas and the duodenum were removed and the retrogastric tail of pancreas was planted into a loop of jejunum (Fig. 18).

There were four operative recoveries from which specimens were removed, belonging to the first class of operations. Of these, 1 was removed the tenth day, 1 the eighteenth day, 1 the thirtieth day and 1 the forty-ninth day after operation (post-mortem findings of the forty-ninth day dog reported in next class). The specimen from tenth-day dog showed good union, no leakage at anastomosis, no pancreatitis and no necrosis. The ends protruding into the intestine were still raw and covered with some fibres sloughing away. The mouth of the duct could not be identified at this stage.

Fig. 15.

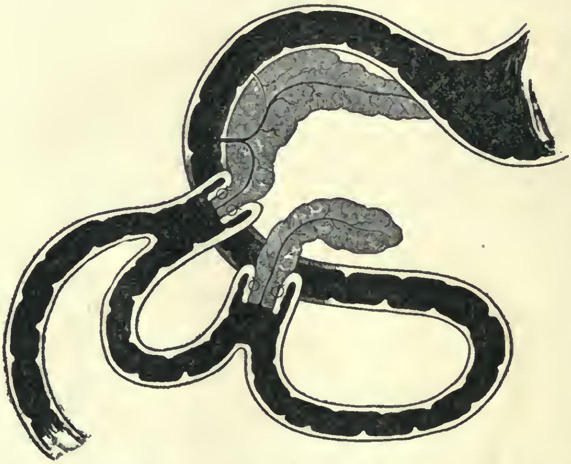
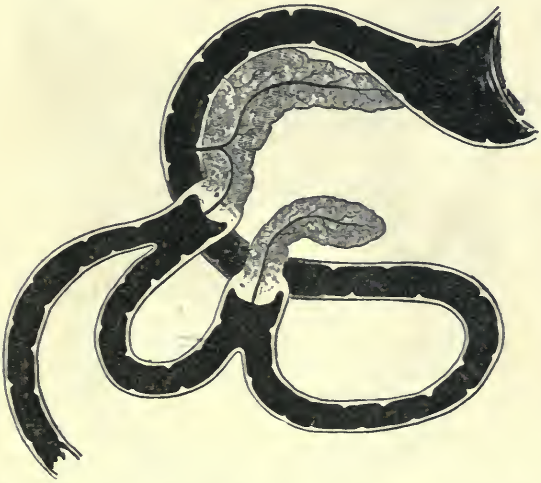


Diagram showing double implantation of cut ends of severed tail of pancreas.

The specimen from the eighteenth-day dog showed similar conditions except that the raw area was smaller, and in the end of the isolated tail the slough had disappeared and the duct could be identified.

The thirtieth-day-dog, at the time of killing had entirely recovered, had a splendid appetite and was rapidly gaining in flesh. On opening the abdomen, no adhesions were found except where the omentum had been tacked to the peritoneum of the intestine. At other points the omentum glided easily over the pancreas, indicating that there had been no leakage. The line of union between the pancreas and intestine was as perfect as if it had been between two intestines (Fig. 12). The same condition existed at the point of each implantation. There was no evidence of pancreatitis or degeneration in either the body or in the isolated tail. On opening each loop, as shown in Fig. 12 we were able to locate the duct after carefully wiping away mucus. (All of our later tests by methylene-blue solution indicate that this duct leading to the body of the pancreas was probably closed by a thin film (Fig. 16) which was wiped off by gauze.

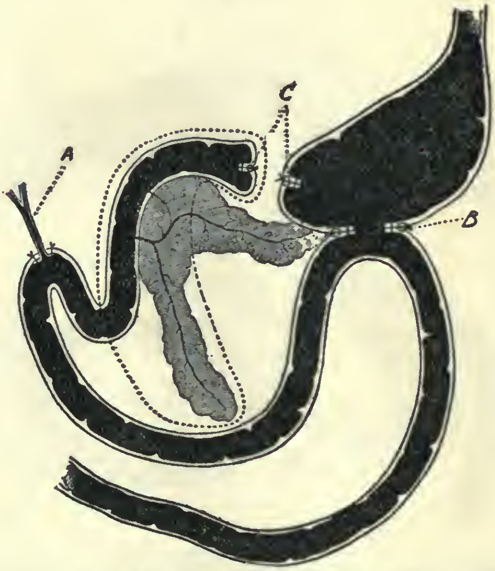
FIG. 16.



Result following double implantation of severed tail of pancreas, showing how isolated tail maintains the opening of its duct while the duct in the other loop heals over. (Diagrammatic.)

In the second class of operations there were 3 operative recoveries from which specimens were removed. Of these 1 dog died on the twentieth day from intestinal obstruction due to a ball of hair which lodged near the ileocœcal valve. One was killed with chloroform on the twentieth day and one was killed with chloroform on the thirty-fifth day. Both twenty-day specimens showed perfect union between the intestine and pancreas, no adhesions in the neighborhood of the implantation, no pancreatitis or evidence of fat necrosis. In both instances, the pancreatic tissue of the retrogastric tail was stripped from the duct and methylene-blue solution injected, when it was found that the implanted cut end had closed, and fluid all came out through the papilla of the old duct of Wirsung unobstructedly (Fig. 16). After grasping the papilla of the duct of Wirsung in a pair of forceps, the fluid flowed freely through the duct of Santorini, and we thought it flowed more freely than in the normal dog. When a filiform bougie was inserted into the opening of the duct of Wirsung and passed down the duct of the tail which had been planted, it went easily to where it could be felt and even seen through a translucent covering which had formed over the cut end of the duct (Fig. 16). On laying open the duct it was found that the ligature which had constricted it had been circumvented and the continuity of the duct re-established. The blue solution which had been injected had passed down into

Fig. 17.

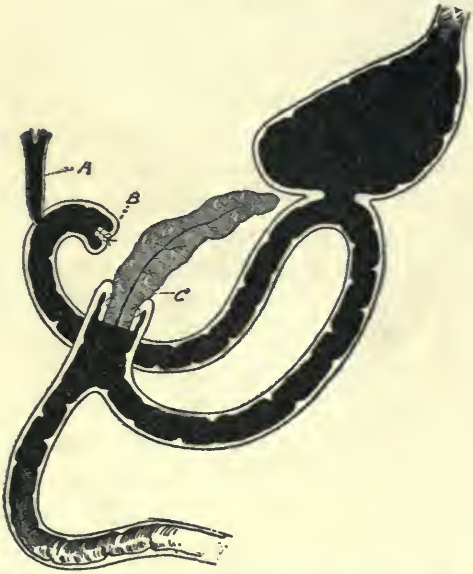


First step in two-stage operation for removing the head of the pancreas, as was done in the first series of experiments. *A*, Bile duct transplanted to intestine below the pancreas. *B*, posterior gastrojejunostomy. *C*, stomach cut in two and ends turned in. Dotted line encloses part to be removed at next operation.

the implanted duct through the intestinal collar but had been held by the film which had formed over its end.

The thirty-fifth-day dog is the same dog reported in the first class as a forty-ninth-day dog, the duct having been ligated fourteen days after double pancreato-enterostomy was done. We may here state that in order to make sure of the ligation, in our early cases a probe was introduced from the inside of the duodenum while the ligature was being placed. The same conditions were found that have just been described in the twentieth-day dogs, namely, a perfectly healthy pancreas, perfect union between pancreas and intestine, closure of the duct of the implanted end of pancreas, circumvention of the ligature which had been placed around the duct of Wirsung, and duct wide open, carrying all of the injected blue solution. When the papilla was grasped, the solution immediately flowed through the duct of Santorini. The implanted isolated tail was in this case perfectly healthy, union perfect, and on strip-

Fig. 18.



Second step in two-stage operation for removing head of the pancreas. *A*, Widely distended bile duct which was transplanted at previous operation. *B*, Remaining stump of duodenum after removal of duodenum and head of the pancreas. *C*, Remaining tail of the pancreas implanted into intestinal loop. (Diagrammatic.)

ping the pancreatic tissue from its duct and injecting the blue solution into the duct, it was found to pass freely into the intestinal loop. A noticeable feature was that one of the linen sutures was hanging in the opening in this case.

In the third class of operations, there were two operative recoveries from which specimens were removed: one eight days and the other thirty-four days after the second step of the operation. The eight-day specimen showed no leakage, no pancreatitis and no necrosis. Implanted end was still in the raw and sloughing state. The thirty-fourth-day dog had the first operation fifteen days before or forty-nine days prior to the time the specimen was removed. The first operation consisted of the transposition of the common bile duct, gastro-enterostomy, and cutting off the stomach as shown in Fig. 17. The thirty-fourth-day specimen showed perfect union, no surrounding adhesions, no pancreatic necrosis, no fat necrosis, but showed evidence of a previous pancreatitis in the form of an induration along the duct which was dilated but not filled with fluid. On stripping the duct and injecting it, the blue solution passed into the loop of intestine by following a thread which had apparently caught the duct at the time of operation and had led the pancreatic fluid through the wall of the intestine by a seton-like action (Fig. 19). The result resembled a hole in the lobe of the ear made for earrings, in that the lining of the duct seemed to be continuous with the mucus side of the intestine. The dog had entirely recovered, had a splendid appetite and was apparently in perfect health. Pancreatitis had subsided and everything in the history of the case pointed to the fact that the duct had been caught in a suture and held until the end had time to heal over, and that during this time the pancreatitis had developed and had subsided as soon as the pancreatic juice began to follow the thread. The common bile duct which had been transplanted at the first operation was as large as a man's finger, while the mouth would admit a lead pencil. The hepatic ducts were distended in the same way well into the liver, but the dog was well and hearty. Five other dogs with the same operation showed the same condition of bile ducts.

From these experiments, it has been learned positively that the cut end of the pancreas may be implanted into a loop of intestine with practically the same assurance of primary union as could be expected from a gastro-enterostomy. Secondly, the dangers of fat necrosis and pancreatic necrosis in pancreato-enterostomy are apparently no greater than the dangers of sepsis in gastro-enterostomy, except in that pancreato-enterostomy is a much more delicate and technically a more difficult operation. Thirdly, it seems that when the pancreas is cut in two the duct retracts into the pancreatic substance and is covered by the healing process unless it is kept open by a flow of pancreatic juice which can find no other easy exit. Fourthly, an isolated portion of the pancreas which has been implanted will maintain communication with the intestine, usually through the end of the duct, but there seems to be

Fig. 19.

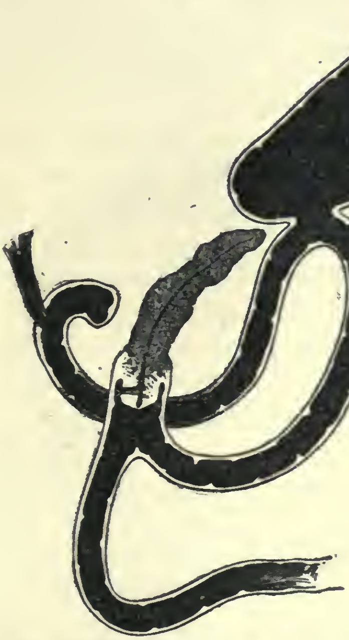


Diagram illustrating result following pancreatectomy in which duct was apparently caught in one of the pancreatic sutures. (Arrow indicates how the pancreatic juice followed out the suture while the end of the duct has healed over.)

special tendency to follow out a thread when present instead of the duct if the duct has been cut off even with the pancreatic tissue. Fifthly, ligation of the duct of Wirsung produces no pancreatitis or pancreatic necrosis when pancreato-enterostomy is performed at the same time; while ligation of the duct of Wirsung without pancreato-enterostomy produces serious consequences in many cases, as shown by all experimenters. Sixthly, the duct of Wirsung is the normal exit for the pancreatic fluid, just as the pylorus is the normal exit for the stomach fluids. So, just as the stomach canal circumvents a ligature which has been placed around the pylorus for the purpose of forcing the gastric fluid through a new opening, so the pancreatic juice circumvents a ligature which has been placed around the duct of Wirsung for the purpose of forcing the pancreatic fluid through a new opening. But it is quite probable that the duct of Santorini could be developed into a substitute for the duct of Wirsung in some cases by planting the tail of the pancreas and thus using the upper end of the duct as a safety valve during the process of development of the duct of Santorini to sufficient size to carry all the pancreatic fluid, after which the duct of the implanted tail would probably close.

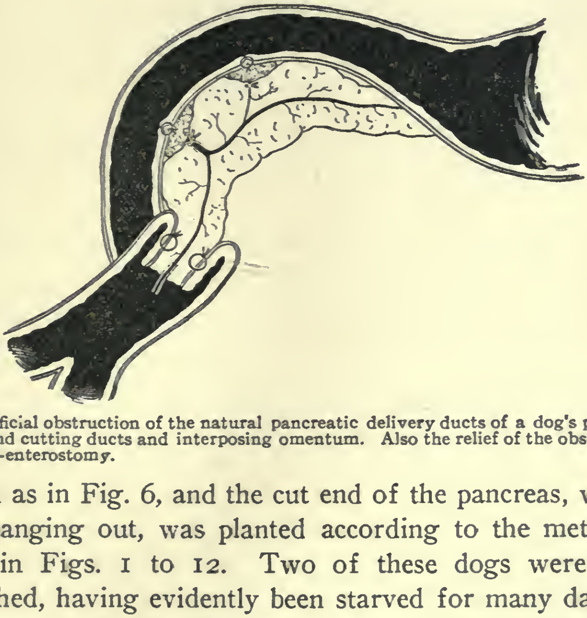
Seventhly, a bile duct which has been transplanted by the direct method, becomes widely dilated and at the same time thickened by intra-intestinal pressure of some kind, which may have a very important bearing on this subject. Eighthly, the persistency with which the cut ends of the ducts tend to heal over leads us to fear the possibility of the eventual cicatricial narrowing of these ducts in some cases unless a special method is used.

SECOND SERIES OF OPERATIONS.

September 13, a second series of operations was begun. These experiments were instituted, first, for the purpose of devising a means of dealing with the pancreatic duct which would prevent the healing pancreatic tissue from covering its end; second, for devising effectual methods of closing the ducts of Wirsung and Santorini simultaneously with the implantation of the tail; third, for devising a physiological operation for implanting the bile duct; fourth, for determining the practibility of implanting the stripped pancreatic duct directly into the intestine by using a reinforcement of omentum.

Beginning September 13, to October 5, 22 operations were done on the bile ducts and pancreas. Of these, 4 were done as follows: The ducts of Wirsung and Santorini were ligated and cut, the intestinal openings of the ducts were turned into the intestine with sutures and the omentum was drawn through the spaces between the pancreas and duodenum to effectually prevent reëstablishment of the ducts (Fig. 20). The end of the duodenal tail was cut off, the duct stripped and the vessels ligated as in Fig. 6, and the cut end of the pancreas, with the duct hanging out, was planted according to the method set forth in Figs. 1 to 12. Two of these dogs were poorly nourished, having evidently been starved for many days, and died—one on the fourth day and one on the eighth day after operation, without having manifested any appetite. No cause could be discovered for their death except inanition. Two of the four were well-nourished, and were operated on September 14. These dogs made an immediate and complete recovery.

FIG. 20.



Artificial obstruction of the natural pancreatic delivery ducts of a dog's pancreas by ligating and cutting ducts and interposing omentum. Also the relief of the obstruction by pancreato-enterostomy.

On the twenty-fourth day after operation they were killed with chloroform. After stripping the duct of the retrogastric tail which had been left, a needle was inserted into the duct and methylene blue solution injected. The fluid passed unobstructedly into the loop of intestine but none escaped into the duodenum. Longitudinal section of the pancreas through the duct for its whole length, including its insertion into the intestinal loop, showed that the duct had been maintained at its full size all the way through to a point slightly beyond the pancreatic tissue of the implanted end. Pancreato-intestinal union was perfect, as it had been in all the other specimens.

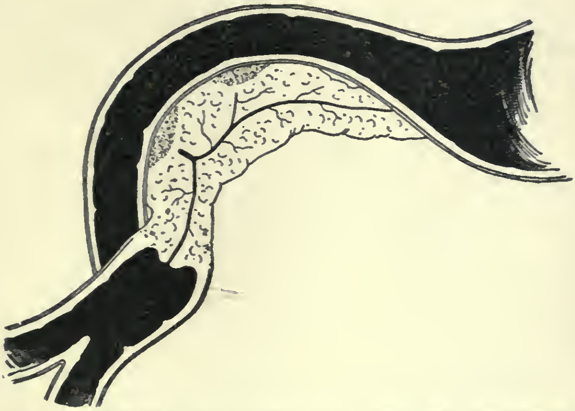
These two specimens effectually remove the defects in our first series of operations and prove that with the ducts of Wirsung and Santorini effectually closed and the duct of the tail allowed to protrude beyond the pancreatic tissue of the implanted end, the pancreatic juice of the other tail and body is easily delivered backwards through the duct of the implanted tail. The experiment, as just described, at once produced the pathology and supplied the remedy for a case of obstruction of the pancreatic duct (from whatever cause), at or near the ampulla of Vater.

PHYSIOLOGICAL IMPLANTATION OF THE BILE DUCT.

Our next defect was in our method of implanting the bile duct. By studying the bile duct of the dog, it is observed to run under the mucous membrane of the duodenum for almost one inch before it opens out into the canal. It is at once seen that this arrangement effectually prevents the intra-intestinal pressure from being brought to bear from within the duct, owing to the fact that it is brought to bear along the course of the duct through the mucous membrane, thus effectually making a valve as shown in Fig. 24. The problem then was to duplicate this condition as near as possible. The first thought was to split apart the layers of the intestine with forceps and drag the duct through. This was a cumbersome method until we were reminded of the protrusion of the mucous membrane which occurs after the outer coats of the stomach and intestine have been cut through, during the operation of gastro-enterostomy. The following operation was, therefore, devised for implanting the bile duct.

First, the duct is located and ligated with linen or silk near its point of entrance into the duodenum. It is then cut in two and the edges caught and held with mosquito forceps while one wall of the duct is split down with a pair of scissors, as shown in (Fig. 22, *A*). A linen suture is now passed through the split end of the duct so as to include about half of it, and tied (Fig. 22, *A*). The linen thread is then thrown around the other half, and tied (Fig. 22, *B*). The loose end is then threaded into another needle. By this method, the full strength of the duct is then retained for traction while the opening is maintained by the split (Fig. 22, *C*). The end of the duct is now

FIG. 21.



Pancreatic juice delivered through implanted duodenal tail. Diagram from specimen 24 days after complete obstruction of ducts of Wirsung and Santorini and simultaneous pancreato-enterostomy.

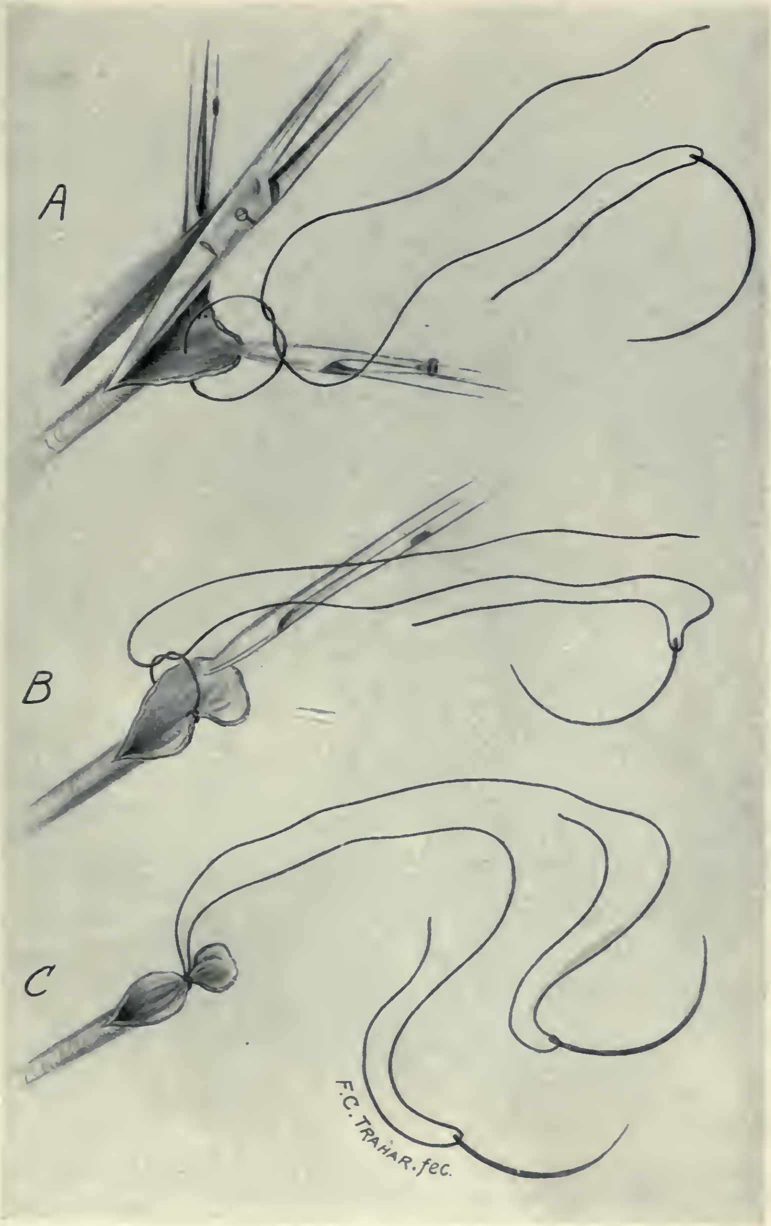
wrapped in gauze while the intestine is prepared for its reception, which is done as follows. Pick up the part of the intestine desired and cut down through the peritoneal and muscular coats including the submucous tissue until the mucous membrane pouts out through the incision (Fig. 23, *A*). This incision should be about one inch long. Second, pass five sutures which pick up the peritoneal and muscular coats, on each side of the incision. Tie the suture at the upper end of the incision. Lift up the three intermediate intestinal sutures on the flat handle of an instrument, as they cross the incision. Make a small stab wound in the mucous membrane near the lower end of the incision. Now bring the intestine close down to the end of the split duct and pass the two needles, carrying the threads on the end of the duct, beneath the three intestinal sutures and into the intestinal lumen through the stab wound in the mucous membrane, and out through the intestinal wall one half to three quarters of an inch further along the intestine and one eighth to one quarter inch apart (Fig. 23, *B*). By making tension on these threads and at the same time pushing the intestine toward the duct, the bile duct is drawn beneath the intestinal sutures and into the intestinal lumen, through the stab wound, when the two ends of the threads on the duct are tied on the outside, thus anchoring the end of the duct on the inside of the intestine at this point (Fig. 24, B). The intestinal sutures are then tied, producing the results shown in Fig. 23, *C*. After this operation the duct lies just beneath the mucous membrane, which has been loosened for approximately three quarters of an inch of its course, so that the intra-intestinal pressure is brought to bear on the duct along this entire distance, thus counteracting the intra-intestinal pressure which in the direct implantation is brought to bear on the inside of the duct (Fig. 24, *A* and *B*).

Two of the dogs on which this operation was done have been killed for the purpose of recovering specimens; one 14 days and the other 15 days after the implantation. The results were ideal. The end of the duct which had been drawn inside the intestine had apparently been digested down to its junction with the mucous membrane so that it was difficult to locate the opening from the inside of the intestine. The bile ducts were enlarged beyond normal but in no degree were they so large as 14-day specimens seen after the direct implantation of the duct. By incising the duct above, a probe was easily passed into the intestine, after which a knife was passed along the probe splitting the duct, which revealed the fact that healing had taken place in accordance with the operation. In short, the specimens indicated the success of the operation both from a mechanical and functional standpoint.

DIRECT IMPLANTATION OF THE PANCREATIC DUCT

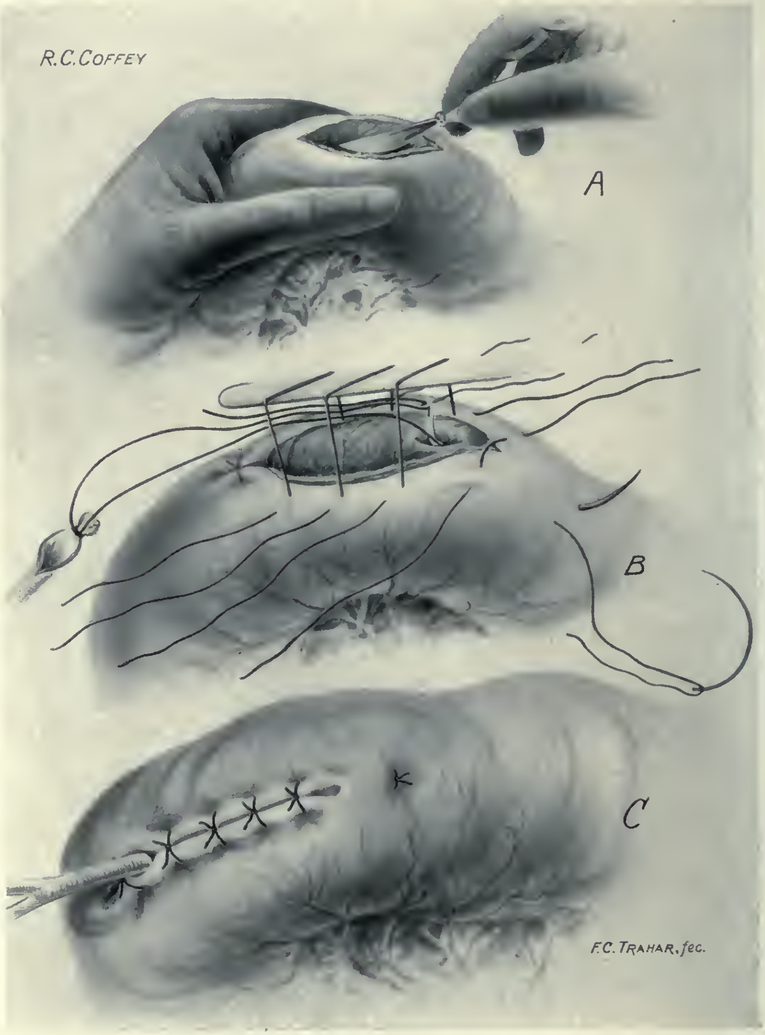
During the last series of experiments we have done direct implantation of the pancreatic duct six times. The pancreas

FIG. 22.



Preparing the bile duct for implantation into the intestine.

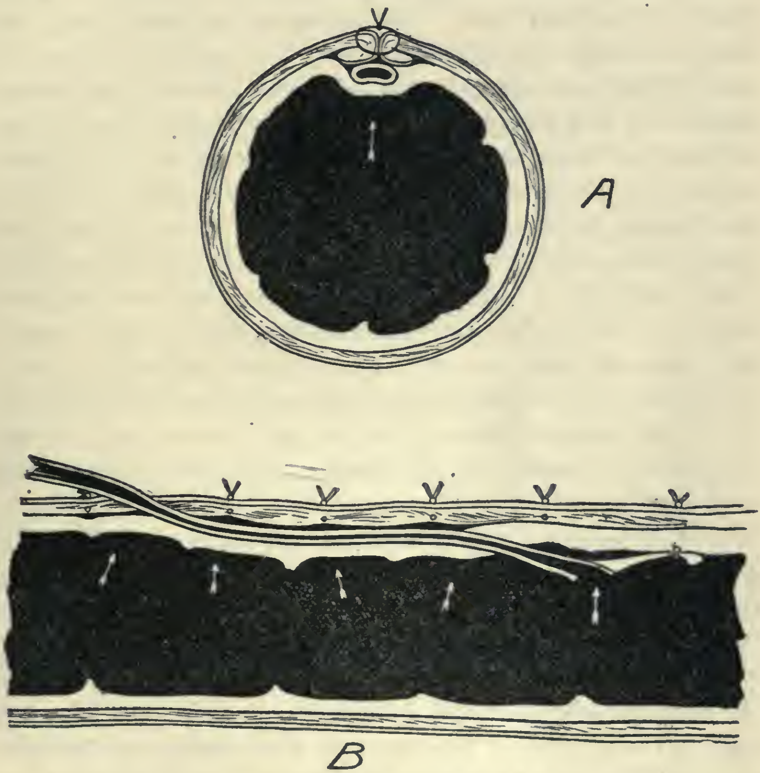
FIG. 23.



Preparing intestine and implanting the bile duct. *A*, Separating the outer coats of the intestines from their membrane. *B*, Drawing the bile duct into the intestine. *C*, Implanting operation complete.

was held against the intestine with extra sutures and thoroughly reinforced by wrapping it with omentum which was fixed in place with sutures to the intestine. Of the six dogs operated on in this manner, one died of shock soon after the operation. Two died of pancreatic and fat necrosis 4 and 10 days after the operation. One died of peritonitis 4 days after the operation. (It is well to state that in this case no omentum was used to surround the duct and leakage took place.) One died 12 days after operation, having shown a slight tendency to eat during the time. The postmortem showed no pan-

Fig. 24.



Sectional view (diagrammatic) illustrating the relation of the bile duct to the coats of the intestine after physiological implantation of the bile duct. (Arrows indicate the direction of intra-intestinal pressure.) *A*, Cross section; *B*, Longitudinal section.

creatic or fat necrosis. On dissection of the pancreas the duct was found to be dilated to the size of a lead pencil. The pancreatic duct, after leaving the pancreatic tissue, had entirely disappeared and healed over so that there was no communication between the pancreatic duct and the intestine. One dog lived until he was killed with chloroform on the twenty-fifth day after operation and was in apparently good health during this time. The pancreas was hard along the duct, indicating chronic pancreatitis. The duct of the pancreas was stripped and injected with methylene blue solution, which passed out into the intestinal canal. On longitudinal section it was found that the duct was much dilated and terminated outside the intestine, but a fistula had up to this time been maintained into the intestinal lumen. Of course we are unable to state whether this would have remained open or would have finally closed. All of the specimens from these six dogs seems to indicate that the pancreatic duct depends very largely upon the adjacent pancreatic tissue for its nutrition; therefore, it can not be transplanted in the same manner as can the bile duct, owing to the fact that it dies as soon as it leaves the end of the pancreas. This suggestion, however, can only be proven by a close histological study of the pancreatic ducts.

While these few experiments are in no way conclusive concerning the second method, we feel safe in predicting that direct implantation of the duct is by no means so safe an operation (if practical at all) as pancreato-enterostomy by the method which we have described. Even if the continuity of the duct could be preserved the anatomical diagrams (Figs. 13 and 14) very clearly indicate that the implantation of one pancreatic duct does not necessarily mean that the other branch ducts will not discharge juice into the neighborhood of the wound. This would be especially true if the tail end of the duct was implanted.

APPLICATION OF PANCREATO-ENTEROSTOMY TO SURGERY OF THE HUMAN PANCREAS.

The foregoing experiments on dogs have been conducted with the primary idea of developing a practical method of re-establishing communication between the pancreatic ducts and the intestine, when such communication has been impeded or destroyed. Such methods have been developed for similar pathology in the stomach and bile tracts. A perfected type of gastro-enterostomy has proven to be the central feature of relief for the stomach, whether the pathology is removed or short circuited; cholecystenterostomy or choledochenterostomy relief for the bile tracts.

The experiments made clearly indicate, to the mind of the writer at least, that pancreato-enterostomy will fill the same place in pancreatic surgery. The experiments prove that pancreato-enterostomy is entirely possible provided we use unbroken peritoneum to make the union with the pancreas.

Owing to the more complete rotation of the human intestinal tract, certain anatomical differences in the arrangement of the peritoneum exist, therefore a slightly different type of operation is required. For instance, the duodenum of the dog is long and for the most part has a mesentery and is therefore covered with peritoneum, making it available. Such is not the case with the human. The peritoneum of the omentum of the dog has not blended with the peritoneum of the transverse colon, therefore there is no gastrocolic ligament or omentum as is found in man and which must be severed to properly deal with the pancreas.

We are at the present time conducting a third series of experiments on dogs with the idea of harmonizing the steps of the operations of pancreato-enterostomy and pancreatectomy on the anatomy of the dog, to the anatomy which we find in the cadaver.

The following steps are recommended for doing pancreatectomy. First, removal of the head of the pancreas, for the description of which step we are indebted to Sauve * who calls special attention to three dangers—injury to the portal vein; injury to the superior mesenteric vessels, which is followed by gangrene of the small intestine; injury to the right

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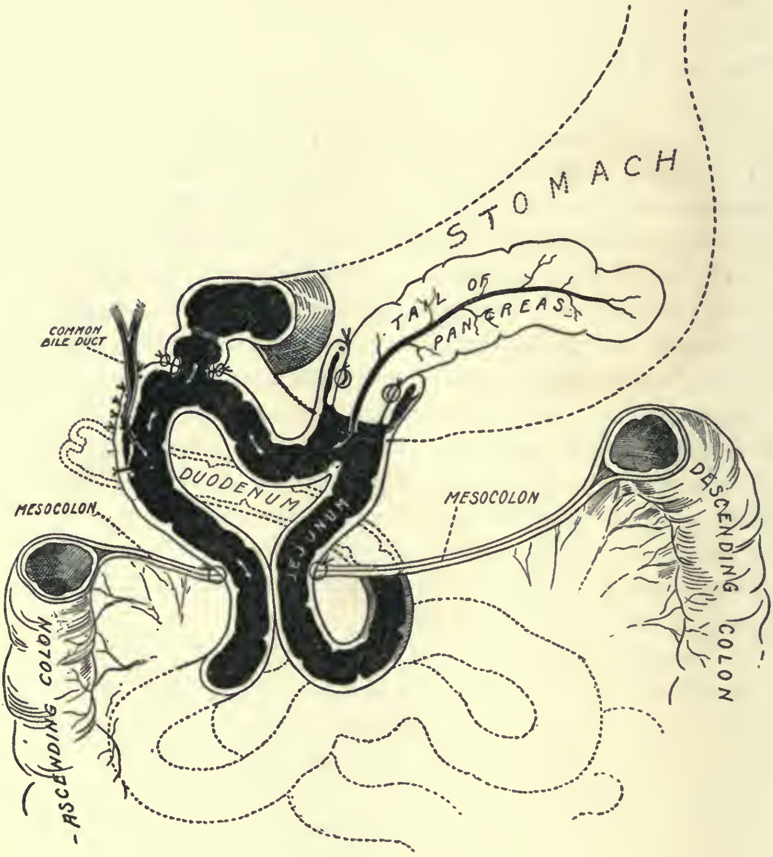
* Revue de Chirurgie, 1908, vol. xxxvii, page 113.

colic artery, which is followed by gangrene of a part of the colon.

Remove the head of the duodenum and pancreas as follows: A median incision from the ensiform to below the umbilicus. Ligature of the pyloric artery and of the gastroduodenal artery. Section of the pylorus, or duodenum just below the pylorus. Division of the fascia along the right border of the duodenum. Posterior dissection of the second portion of the duodenum and the head of the pancreas.

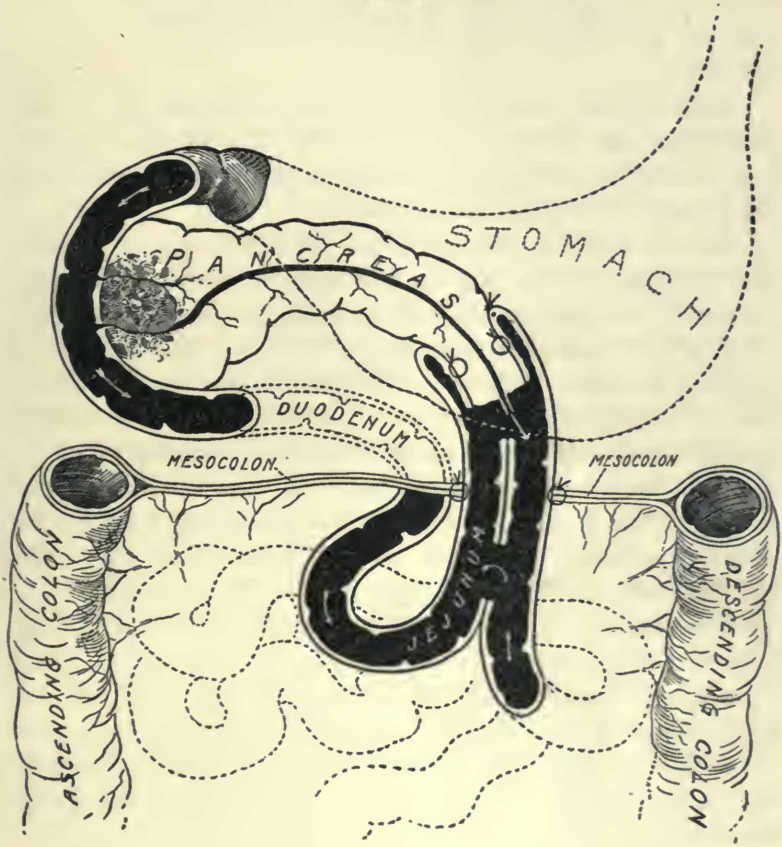
FIG. 25.



SCHEME OF OPERATION FOR REMOVAL OF THE HEAD OF THE PANCREAS AND DUODENUM

Section of the duodenum at a point sufficiently far from the superior mesenteric vessels to protect them from injury. The dissection of the duodenum should be carried to a point

FIG. 26.



SCHEME OF PANCREATO-ENTEROSTOMY. WITHOUT PANCREATECTOMY.

at which it can be easily separated from the head of the pancreas, but not to the mesenteric vessels. Ligation below of the pancreato-duodenal vessels. Section of the duodenum and suture of its lower end.

Separation of the "lesser" pancreas from the mesenteric vessels which cross in front of this portion.

Separation of the pancreas from the portal vein. Section of the head of the pancreas. Ligation and division of the common bile duct and division of the gastroduodenal artery, and the portions of the duodenum and pancreas are thus removed.

Now the cut end of the bile duct and the cut end of the stomach or duodenum, as the case may be, are held in clamps and the cut end of the pancreas wrapped in gauze awaiting implantation into the loop of jejunum.

Second step: If the gastrocolic omentum has not already been severed to permit a good exposure for work, it may now be done. An opening is made through the transverse mesocolon near its root, through which a loop of jejunum one or two feet in length is drawn. The pancreas is now implanted into the upper portion of this intestine,—lower down the stomach or duodenum is anastomosed, and still lower down the common bile duct is implanted. A few interrupted linen sutures fasten the intestine to the mesocolon as it passes up and down through the slit. These sutures also close the opening and prevent hernia (Fig. 25).

Pancreato-enterostomy without pancreatectomy (Fig. 26) may be done in the human as follows:

First, divide the gastrocolic omentum and loosen the tail of the pancreas by dissection and ligation of vessels.

Secondly, pick up a loop of jejunum as near to the ligament of Treitz as possible, and yet long enough to reach the tail of the pancreas with ease.

Thirdly, entero-enterostomy between the limbs of the loops.

Fourthly, make a hole through the mesocolon well to the left of the ligament and draw the loop of intestine through the opening.

Fifthly, strip and cut the duct of the tail of the pancreas and plant it into the loop by the method previously described in this paper. Fasten the intestine to the mesocolon where it passes in and down through the opening.

Sixthly, repair gastrocolic omentum.

A DISEASE OF THE GALL-BLADDER REQUIRING CHOLECYSTECTOMY.

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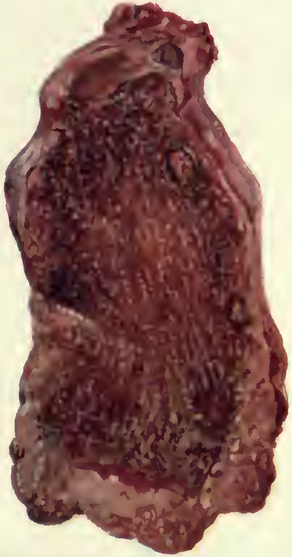
I do not doubt that it has fallen to the lot of many surgeons to operate upon patients supposed to be suffering from gall-stones when an examination of the gall-bladder and the ducts has revealed the existence of no calculus. In the recent literature there are several papers, none more eloquent than that of Dr. Maurice Richardson (*Boston Med. and Surg. Journ.*, 1907, i, 687), dealing with this question. When the diagnosis in such cases has been proved to be incorrect we have perhaps sought to explain the error by the doubtful existence of chronic pancreatitis, or by the presence of a thick, ropy, "tarry" bile, which, we have thought, may escape down the ducts with a difficulty no less than that of a solid concretion. These explanations may no doubt be acceptable in many of the cases, but I have long had an uneasy feeling that we must be overlooking some elusive condition, and I became confirmed in my anxiety when I found that some of these cases in my own hands (and so far as I can learn in those of others also) showed no permanent improvement after the performance of cholecystostomy, though their symptoms might for a brief period be relieved.

During the last two years a series of cases revealing to me a condition of which I was previously unaware, have come under my notice. This condition is one which I think may explain some of the cases of "cholecystitis without gall-stones" which we have treated without success by cholecystostomy. The history in all is of the same kind, though there are variations both in the intensity of the symptoms and in the signs which are discovered when the gall-bladder is examined.

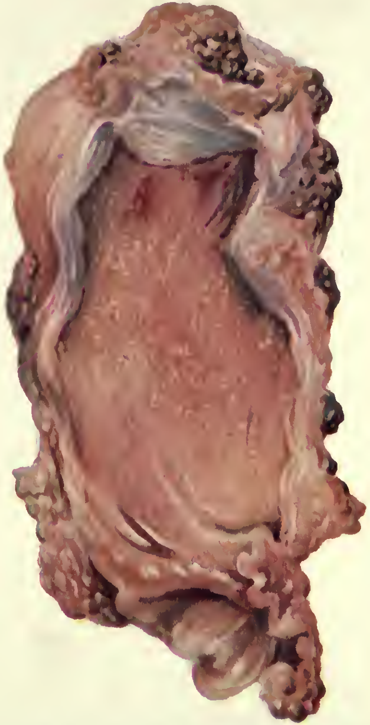
Briefly the history is one in which there has been a period of "indigestion" lasting always for months, sometimes for years. There have been discomfort, a sense of weight, fulness or distention after meals, and heartburn or acidity, and in consequence the diet may have been much restricted. At intervals, "attacks" of pain occur, attacks which are usually severe, sometimes agonizing, and may be attended by shivering. The pain in all its attributes is exactly that described as "hepatic colic" and a faint tinge of jaundice may follow; after an attack the gall-bladder may be palpable, and for some days a sense of soreness and of stiffness may be felt in the side. On such evidence as this a confident and most reasonable diagnosis of gall-stones may be made. When the abdomen is opened the gall-bladder may appear to be quite healthy. In one of my cases the gall-bladder was absolutely normal in appearance; it had the blueness of health, and the gland by the side of the cystic duct was not enlarged. In this case, as in all, the bile was found to flow with difficulty when a needle was thrust into the gall-bladder. The bile is thick, dark in color, tenacious, and often sticky. It may be like a thick solution of rubber; it is tarry and black. As it flows on to a swab the sparkle of cholesterin crystals may be seen. It is at this point that the mistake may be made of completing the operation by inserting a tube into the gall-bladder and in being content with drainage. If now the interior of the gall-bladder be inspected a curious appearance is presented. The whole of the mucosa is thickly dusted with fine stones: the stones are numberless, of small size, and they fit snugly into the pits on the reticulated surface of the mucous membrane. The fine calculi are indeed embedded in the wall; they cannot be brushed away, and scraping the surface with a spoon or with dry gauze does nothing to move them. The coarse particles of grit are ingrained. When the whole interior is displayed it is seen that the number and the size of the fine stones increase as the cystic duct is approached; at the beginning of the duct they stop abruptly in a perfectly straight line. The mucosa of the duct itself is usually intact, smooth and free

FIG. 1.



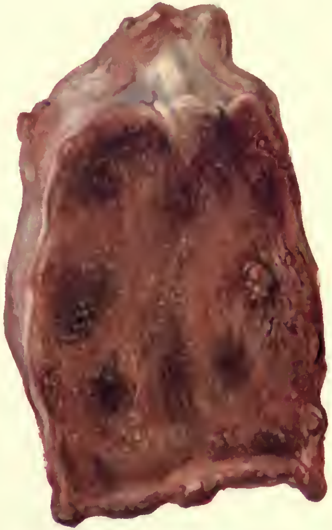
CASE I.—Gall-bladder almost normal in appearance from without; the mucosa is studded with fine grains of cholesterin stones.

FIG. 2.



CASE II.—Gall-bladder, much thickened. Advanced cholecystitis. No stones other than the fine sandy deposit ingrained in mucosa.

FIG. 3.



CASE III.—Cholecystitis only present at the fundus; the remainder of the gall-bladder quite healthy.

from all trace of grit. The wall of the gall-bladder itself may appear normal, or it may be thickened at the fundus, and normal elsewhere, or it may be white and slightly thickened, or finally it may be dense, thick, opaque with a cavity much reduced in size. I have met with every grade of cholecystitis from the mildest to the very severe. The most common condition is to find the gall-bladder almost normal, retaining much of its natural blue color, and all of its smoothness and suppleness. These are the cases it is most essential to recognize, for in them also the removal of the gall-bladder is the only course of treatment likely to be attended by lasting success.

In two of my cases there was well marked chronic pancreatitis, excited doubtless by the repeated irritation of infected bile.

When I look back upon my cases during recent years I find many records similar to the type I have briefly related; inspection of the gall-bladder did not show, as had been expected, any evidence of stone; the bile is often said to have been " muddy " " tarry," " tenacious "; some of the cases seem to have been completely relieved by drainage; a few are still troubled by their symptoms which have returned almost unaltered. In a small number, possibly six, I have operated a second time, and have removed a gall-bladder that seemed smaller and whiter than normal; and I have attributed this change from its normal appearance to my earliest handling of it. It is almost certain that I have often overlooked the existence and the significance of the change in the gall-bladder which I am now describing.

CONCLUSIONS.

1. There is a condition of the gall-bladder in which fine grains of calculous material are embedded in the mucosa; the cystic duct is not affected.

2. The wall of the gall-bladder may appear normal. It may retain the blue color of health and the walls are thin and supple. It may be white and thickened, slightly or grossly, in part or in whole.

3. No stones are free in the gall-bladder, though particles of grit may be found in the bile therein.

4. Chronic pancreatitis may be present in the more advanced cases.

5. Inspection of the mucosa of the gall-bladder is necessary to reveal the presence of this condition in its early stages; it cannot otherwise be recognized.

6. Removal of the gall-bladder is necessary; drainage of the common duct may be desirable in cases where jaundice has been present.

The following are three illustrative cases:

CASE I.—*Minute Concretions in Gall-bladder; Chronic Cholecystitis; Chronic Pancreatitis; Cholecystectomy, Appendicectomy.*—Woman, aged 42, sent by Dr. Walsh Tetley. The patient had always been rather a bilious subject, but enjoyed fairly good health until twelve months ago, from which time the present illness dates. The following history was given by Dr. Tetley:

The earliest symptoms noticed were loss of appetite, "indigestion," with sickness and a sense of uneasiness after food. The pain was not acute but caused depression and a peevishness of temper. The discomfort came on from half an hour to one hour after food, and was always referred to the right epigastric region. On April 9, 1908, she had a severe attack of pain which came on immediately after taking walking exercise; it was stabbing in character and was accompanied by a chilly sensation. The pain commenced in the epigastric region and went round the right side to the back. She became rather yellow afterwards. She was kept in bed five days.

May 1, 1908: Slightly jaundiced. May 9, 1908: Patient did not feel so well; felt sickly and had "indigestion pain" and could not take food. May 23, 1908: Felt better and was permitted to take a walk which was followed by an attack of pain in the right side, similar in character to the attack which occurred on April 9. She was kept in bed for a week or ten days. June 8, 1908: Had a very severe attack of excruciating pain which was again referred to the right epigastric area and right hypochondrium. The attack passed off in the evening and left her very yellow. The following day the fæces were examined but no stones were found.

June 10, 1908: A diagnosis of duodenal ulcer was made by those in charge of the case. Still much sickness; milk could not be digested when taken in conjunction with citrate of soda. Her condition did not yield readily to treatment, but the patient improved slowly for two or three weeks when the improvement came to a standstill.

August 23, 1908: On this day I (Dr. Tetley) first saw her and found her condition to be as follows: The patient was obviously wasted, which could be accounted for by her long illness and diet; complained of constantly feeling "sickly, with indigestion pains" and a "weakness" in the right side, which weakness often amounted to pain which could be brought on by movement, coughing or taking a deep breath. She said she felt something "wanted to be forced" in her right side. She was slightly jaundiced.

Examination of abdomen revealed very slight fulness over the right epigastric region. On palpation there was extreme tenderness over the gall-bladder area which was aggravated upon taking a full breath. The enlargement of the gall-bladder could be made out and no increase of liver dulness. The breath was offensive and tongue clean. Temperature and pulse normal. Bowels very constipated, fæces black, due to administration of bismuth. Appetite was capricious, but there was a general loathing for food and particularly for certain articles—for instance, tea and coffee.

September 21, 1908, 10 A.M.: Under examination of the abdomen the gall-bladder was found to be greatly distended and extremely tender to touch. She complained of not feeling so well; felt very sickly. At 2.30 P.M., the same day, she had a very severe attack of pain in the gall-bladder area, with sickness. The pain, which was of a stabbing character, went round to the back and towards the right shoulder. The attack was accompanied by a feeling of chilliness and shivering which did not resemble a rigor. Breathing was shallow and quick; a deep breath greatly aggravated the pain. The expression was haggard. Temperature was normal; pulse slightly increased in frequency. The distention of the gall-bladder, noticed four and one-half hours previous, had disappeared. Warm applications were applied and the attack passed away.

September 22, 1908: Jaundice present to slight extent. Urine normal. Fæces contained large quantity of thick bile-stained mucus, but no stones or gall sand. Patient having recovered from the attack continued to improve until October 27, 1908, when she had another attack similar in character but of less severity. No bile in urine. Fæces contained again a large quantity of bile-stained mucus, but no stones or sand. October 28: She said she was always in dread of another attack and although her general health had much improved she felt there was still something wrong in her right side. At this date surgical treatment was recommended.

Diagnosis: gall-stones. Operation: November 12, 1908. Incision through the right rectus muscle; the gall-bladder appeared normal and no calculi were palpable. The pancreas was enlarged and the lobes easily defined. There were a number of adhesions between ascending colon and omentum and parietal peritoneum in the right iliac fossa; these were separated and the appendix brought to surface; it was long but did not appear to be inflamed; appendicectomy.

The gall-bladder was opened and the mucosa was then seen to be studded with minute concretions. Cholecystectomy, ligature of cystic duct; tube passed down to stump. Healed *per primam*. Convalescence uneventful.

The gall-bladder specimen was a thin-walled sack measuring 2½ x 1½ inches when opened. The mucous membrane was bright red, and scattered uniformly over its surface were minute yellow concretions. One of these rather longer than the others was attached to the mucous membrane about ¼ inch below the opening of the cystic duct. There were no calculi and no definite naked-eye inflammatory changes in the bladder wall.

Microscopic sections show a well marked and a considerable variation in the thickness of the bladder wall. This is due mainly to irregular thickening of the outer (fibrous) layer and to hemorrhagic infiltration and congestion of vessels in all the layers. The mucous membrane is shed in some parts, in others it is thrown into irregular folds and shows proliferation of the epithelial cells.

Case II.—*Chronic Cholecystitis; Chronic Pancreatitis; Drainage of Hepatic Duct; Cholecystectomy.*—Male, aged 57. Sent by Dr. Kidd, Enniskillen. The history is given in the patient's own words: "In the year 1904, I, a working journalist, suffered from pains in my chest, just at the angle where the ribs join to form the breast; and the pain extended down the line of the right rib, in some cases as far as the lowest rib. I was treated for indigestion and told I had chronic dyspepsia. These attacks were relieved invariably by alkali draughts, and by vomiting, and I did not consider them of serious consequence. But they increased in violence, and in October, 1907, I suffered severely from the gnawing pain, from the consequent want of sleep and the use of sleeping powders and the loss of strength and flesh; and while one consultant mentioned gall-stones, no remedy beyond the use of Carlsbad salts was suggested, and I was sent to an eminent physician in Dublin. He, like the other doctors consulted, found my chief organs to be sound; his treatment reduced the pain and his rule as to diet produced better health, and I enjoyed good health in consequence until the last days of July, 1908. I then felt a pain at the same angle at the upper part of the abdomen as before, for over a week, and it developed into the old soreness which extended down the line of the right rib. It was only relieved by hot water drinks and fomentations and vomiting, with diet of the lightest kind. I recovered so far as to be able to go for short walks, when I suddenly got a shivering fit at my own fireside, which lasted for two hours and was followed by a profuse sweating, and I had to return to bed. I had had a slight touch of jaundice before this attack, which was wearing off when I had those walks, and it now returned. Despite the utmost care and the best of nursing, the shivering attacks and the sweatings returned, so that I became greatly reduced in strength and in flesh, and looked wretched. Food became hateful, for pain in the right abdominal region (in the region of the liver) followed the use of food, even although I confined myself to liquids or steamed fish. The jaundice varied in intensity, though not severe at any time; I became much depressed in spirits and somewhat emaciated. My lower limbs were itchy, and I had an aversion to exercise."

A diagnosis of calculous cholecystitis with chronic pancreatitis (a positive Cammidge's reaction was present) and probably obstruction by a loose stone in the common duct was made and an operation performed on September 2, 1908. The usual incision was made. Gall-bladder thick-walled, no calculi palpable. Head of pancreas slightly enlarged. Common duct dilated, a number of enlarged soft and discrete glands along the common duct and another over cystic duct. The cystic duct felt hard and thickened and the gall-bladder was removed as it was feared that a stricture might be present. The common duct was inclosed and explored but no stone felt in either it or the hepatic duct. Drainage tube passed into hepatic duct and fixed by suture. Encircling rubber tube passed down to kidney pouch.

Convalescence satisfactory; the patient left for home on the twentieth day, and writes in February, 1909, to say that he is perfectly well, and has lost all his old indigestion; he eats heartily, looks well, and is in full vigorous health.

CASE III.—*Minute Concretions in Wall of Gall-bladder. Local Cholecystitis, Cholecystectomy.*—Mrs. B., aged 25. Sent by Dr. Batten, Morecambe. For five years the patient has suffered from "indigestion"; there has been flatulence and distention of the epigastrium after meals, especially after vegetables have been taken. On several occasions severe attacks of pain lasting two to twelve hours have occurred. The pain has been felt across the upper part of the abdomen, and has left a great tenderness for two to three days; this has been more marked on the right side. During the last three months had had four attacks of this kind; the pain has lasted two to four hours, and has needed morphine for its relief. In the last two attacks there has been slight shivering; after all these has been faint and fleeting jaundice.

Operation, March 29, 1909.—An incision was made over the gall-bladder, which contrary to expectation contained no stones. The fundus of the gall-bladder looked a little whiter than normal, and was distinctly thickened. There were no stones in any part of the biliary tract. The gall-bladder was opened, and its interior inspected. It was then seen that the wall, at the fundus, was thicker and whiter than normal. Over the greater part of the interior fine sandy deposits of gritty material were seen. The gall-bladder was removed. The patient made a quick and easy recovery from the operation.

TRANSDUODENAL CHOLEDOCHOTOMY.

REPORT OF A CASE, WITH COMMENTS ON THE CLINICAL AND OPERATIVE FEATURES.

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THE operation for the removal of stone from the second (retroduodenal, pancreatic) or third (intramural, interstitial) part of the common bile duct, by the transduodenal route is sufficiently rare and interesting to justify a record of all cases.

CASE.—Mrs. H., age 38, was admitted to St. Boniface Hospital complaining of attacks of severe pain in the gall-bladder region, accompanied by jaundice. On the morning of September 1, 1906, she complained of loss of appetite, and felt nauseated. In the evening she was seized with a severe attack of pain in the right hypochondriac and epigastric regions. The pain radiated to the shoulder and down the arm and was accompanied by chills, fever, and vomiting. Four days later jaundice developed, and persisted to a marked degree throughout her illness. Attacks similar to the one described occurred about every two weeks, the jaundice deepening with each attack though becoming somewhat less intense in the interval. Three months from the onset, in addition to the attacks of colic, pain and discomfort became a constant feature in the gall-bladder region. This condition persisted till the time of operation—a period of sixteen months—during which the patient's stools were clay-colored, and her weight diminished twenty pounds. Muscular weakness was present and headaches of a severe occipital type were complained of. Urinalysis revealed nothing abnormal save the presence of bile. Ten years ago the patient had typhoid fever, which was followed by what she termed "bilious attacks." With this exception her personal and family history are of no interest. Physical examination revealed tenderness and resistance in the right upper quadrant of the abdomen, but no tumor was palpable.

From the history and symptoms, I concluded that I had to deal with stone in the common duct, and therefore advised operation.

Operation: January 2, 1908.—Incision, vertical, three and a half inches in length over the upper part of the right rectus muscle, separating its fibres and dividing its posterior sheath and peritoneum. The intestines in this region were found adherent to each other and to the under surface of the liver, and neither gall-bladder nor any part of the bile ducts could be seen. Palpation of the under surface of the liver, through the adherent intestines, revealed a slight thickening in the gall-bladder region, but nothing suggestive of stone. Palpating along the descending portion of the duodenum, a hard circumscribed mass was felt which seemed to be a stone in the retroduodenal portion of the duct. Again thoroughly examining the gall-bladder, I satisfied myself that the stone palpated was the only one present. Separating the adhesions to the right of the duodenum and tearing through the posterior parietal peritoneum with the finger, the duodenum was mobilized sufficiently to bring it with the mass well up into the incision. Carefully protecting the peritoneal cavity and edges of the wound with suitable pads and inserting two traction stitches in the duodenal wall (the first two fingers of my left hand meanwhile supporting the duodenum) I incised both anterior and posterior walls, cutting directly over the stone. When the stone, which was firmly embedded in the fibrosed wall of the duct was removed, bile flowed freely into the duodenum. Exploration of the duct revealed no other obstruction. No dead space existing between the duct and the posterior duodenal wall no stitches were here necessary. The incision in the anterior wall of the duodenum was longitudinal, and was closed with a double row of sutures in the same direction. The abdominal wound was closed without drainage.

The patient's recovery was rapid and uneventful, neither temperature nor pulse reaching 100. She left the hospital on the fourteenth day, the wound entirely healed and the jaundice rapidly disappearing. Four months later she had more than regained her former weight and was in excellent health.

Commentary.—This case presents several points of clinical and surgical interest.

The history the patient related of attacks of pain accompanied by chills, fever and vomiting, with deepening jaundice, pointed almost conclusively to a case of biliary colic with intermittent hepatic fever (Charcot's[1] syndrome). One would be therefore justified in arriving at the conclusion that the icterus was due to gall-stone obstruction of the common duct rather than to obstruction from pressure without the duct, either of inflammatory or neoplastic origin. The absence of these symptoms, however, would not necessarily exclude a diagnosis of gall-stone as the cause of obstruction, as is illustrated in a case recorded by Rolleston,[2] where the patient had neither pain nor colic and yet a large stone was found post mortem in the common duct.

The shrunken condition of the gall-bladder in this case is also of interest in conforming to Courvoisier's[3] well-known law. It is quite probable that the "bilious attacks" which followed the typhoid fever were attacks of cholecystitis, which was the determining factor in the formation of stone and sclerosing and subsequent shrinking of the gall-bladder.

In looking over the literature I was very much impressed with the frequency with which stones have been overlooked in the common duct; especially does this apply to its retroduodenal portion and ampulla, and one cannot emphasize too strongly the importance of carefully and systematically examining the duct in all its parts in every case of gall-stones. One is most likely to neglect this precaution in cases of gall-stone disease unaccompanied by jaundice, as stones may be present in the common duct though this symptom be absent. That a large stone may be present in the common duct without causing jaundice, is pointed out by Osler and McCrae,[4] and Kehr[5] says that in case of stones in the ductus choledochus (even in the absence of gall-bladder intestinal fistula) icterus was absent in 33 per cent. of the cases.

The pancreas in this case showed no definite pathological change. This was probably accounted for by the fact that the stone was impacted above the ampulla of Vater and therefore caused no obstruction to the duct of Wirsung. There was no trouble from hemorrhage either at operation or subsequently;

and according to Robson and Cammidge[6] this complication is less likely to occur in those cases of cholemia due to pure gall-stone obstruction than in those dependent on or complicated by disease of the pancreas.

The stone was oval in shape and measures five-eighths of an inch in its longest diameter. It was not facetted.

I have already mentioned that the wall of the duct was not sutured to the posterior wall of the duodenum (Kocher's choledochoduodenostomy). The pressure of the stone had obliterated any dead space, and, therefore, sutures were unnecessary. If, however, sutures are necessary in this situation the advice given by Elliot,[7] to secure the edges of the duct and duodenal wall with forceps or ligature before removing the stone, is good; for the instant the stone is removed the duct and posterior wall slip from the fingers and suturing would be difficult.

Closure of the duodenum, which is probably the most important step in the operation, was effected by a through-and-through continuous mattress suture (Connell suture) inverting and apposing serosa to serosa, and this was reinforced by a Cushing continuous right-angle suture.[8]

The question of drainage in gall-stone disease is a most important one. Here the considerations are two-fold: namely, drainage of the biliary apparatus *per se,* and drainage of the abdominal cavity. Almost invariably, a disease of the biliary apparatus calling for surgical interference, is a condition also calling for drainage. Drainage of the abdominal cavity is called for only when there is oozing from much tearing of adhesions, soiling during operation or a preceding septic infection.

In this case the bile drained freely into its normal channel, the duodenum, through the fistulous opening made in removing the stone.

There being no oozing, and the greatest care having been taken to avoid soiling of the peritoneum and edges of the wound, drainage of the abdominal cavity was not necessary.

For these reasons I cannot agree with Connell,[9] who says that drainage is essential in all cases either by performing a cholecystostomy or a choledochostomy. To have attempted either in this case would have meant further and extensive separation of adhesions, greater traumatism and prolonged operation followed by greater shock and less satisfactory convalescence. One cannot speak dogmatically with an experience of one case, but both Moynihan[10] and Mayo[11] say that drainage in these cases is unnecessary. On the other hand, I agree that if stones are present in the biliary passages higher up or in the gall-bladder, then drainage is a *sine qua non*.

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ILEUS DUE TO MECKEL'S DIVERTICULUM.

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EMBRYOLOGY AND ANATOMY.

THE following description, partly from Piersol, will serve to refresh one's memory in regard to the origin of the structure whose persistence may be the cause of a number of different pathological conditions in postuterine life.

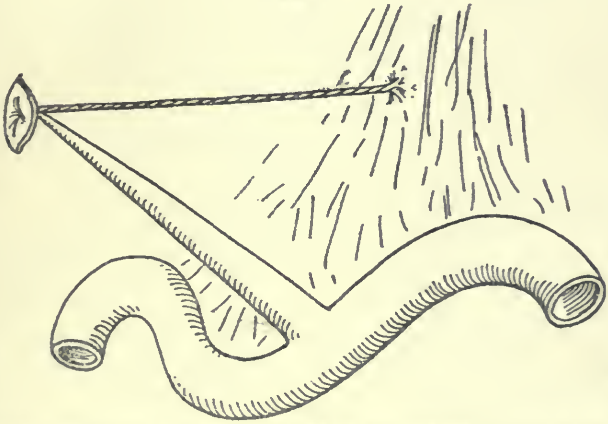
The umbilical vesicle, as the yolk sac in man is called, is relatively large during the first two weeks of embryonic life. The early human embryo is very imperfectly differentiated from this large and conspicuous yolk sac, with which its ventral surface widely communicates. With the advances made during the third week in the formation of the primitive gut, the connection between the latter and the vitelline sac becomes more definitely outlined in consequence of a beginning constriction which indicates the first suggestion of the later vitelline or umbilical duct. During the fifth and sixth weeks this duct is reduced to a narrow tube, extending from the embryonic primitive gut to the chorion, where it ends in the greatly diminished umbilical vesicle. The lumen of the umbilical duct is conspicuous during the earliest months of gestation, but later disappears. In cases in which the closure and obliteration of the vitelline duct before birth are imperfectly effected, a portion or even the whole of the intra-embryonic segment of the vitelline or umbilical duct may persist as a pervious tube. The vitelline or umbilical duct is accompanied in the embryo by the umbilical vessels. The latter, like the duct itself, may persist and be found close to the diverticulum, having an independent course (Figs. 1 and 2) or lying along the free border of the mesenteriolum of the persistent diverticulum (Fig. 3). A vascular cord containing the vessels alone may persist without any or only a rudimentary diverticulum and run independently from the mesentery to the umbilicus. Owing to the fact that the umbilical vessels empty into the mesenteric vessels, the cord containing the vessels always terminates at one end in the mesentery (Fig. 4) where its relation to the mesenteric vessels can be readily traced even in adult life.

Varieties of Persistent Umbilical Duct or Vessels.—The following conditions may exist after birth:

1. A complete canal opening at the umbilicus at one end and into the ileum at the other—comparatively rare. (Fig. 5A.)

2. A canal opening at the umbilicus but ending blindly at a variable distance within the abdominal cavity.

FIG. 1.



Meckel's diverticulum and vascular cord attached separately to the umbilicus.

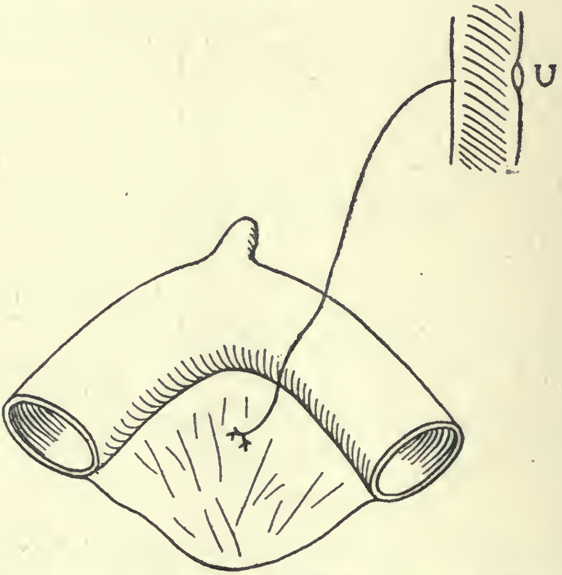
3. An intermediate portion of the duct remains, having no communication externally at the umbilicus or internally into the gut, but forming a cystoma due to retention or secretion. Such a cystoma may have a ligament attaching it to the gut (Fig. 6).

4. The tube is limited to the proximal end of the canal opening into the ileum (Fig. 7). This is the variety generally known as Meckel's diverticulum, because Meckel [2] in 1812 was the first to direct attention to its importance as the cause of various pathological conditions after birth. Its existence had been known and it had been accurately described by others, but Meckel was the first to describe it accurately and show its relation to umbilical fistula and intestinal obstruction.

5. The cord containing the umbilical vessels may persist as

an independent structure and be attached to the umbilicus separately (Fig. 3). As was stated above, this vascular cord may either take an independent course or the vessels run along the free border of the mesenteriolum of the diverticulum, or finally—and this is a very frequent condition—they may run from the tip of the diverticulum and form a cord commonly known as the terminal ligament, whose points of attachment will be mentioned below.

FIG. 3.

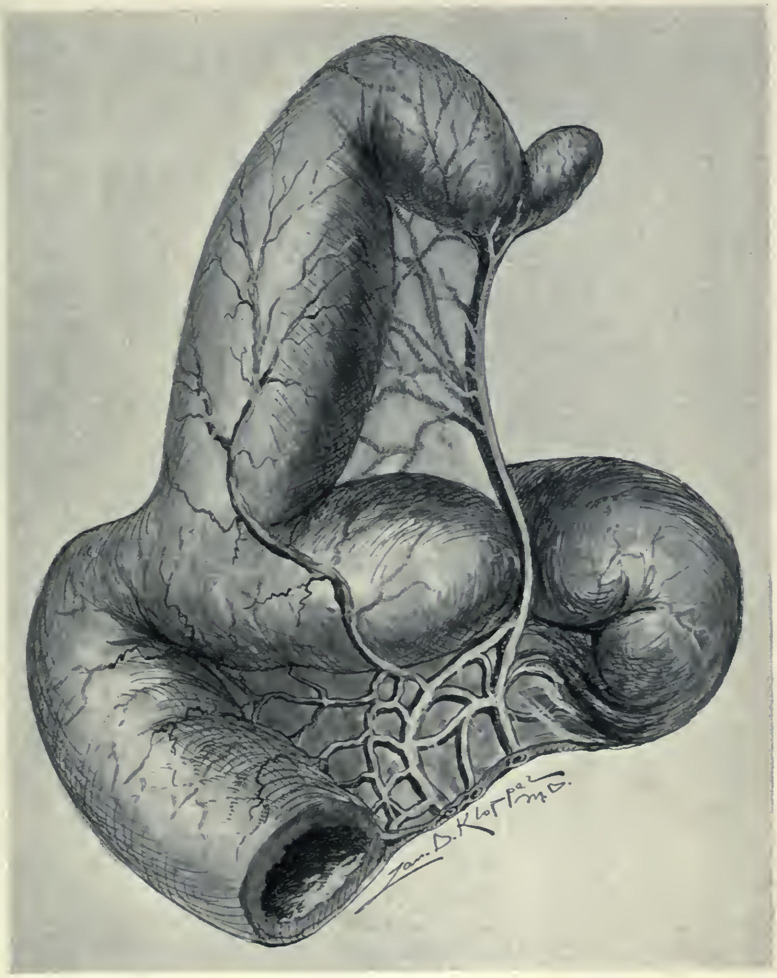


Persistence of the vascular (omphalomesenteric vessels) cord from the mesentery to the umbilicus, with rudimentary diverticulum (Wilms).

6. The diverticulum may be either absent or very rudimentary (Fig. 3), and the only evidence of the presence of a congenital condition be a cord (containing the umbilical vessels or traces of them) extending from the mesentery to the umbilicus.

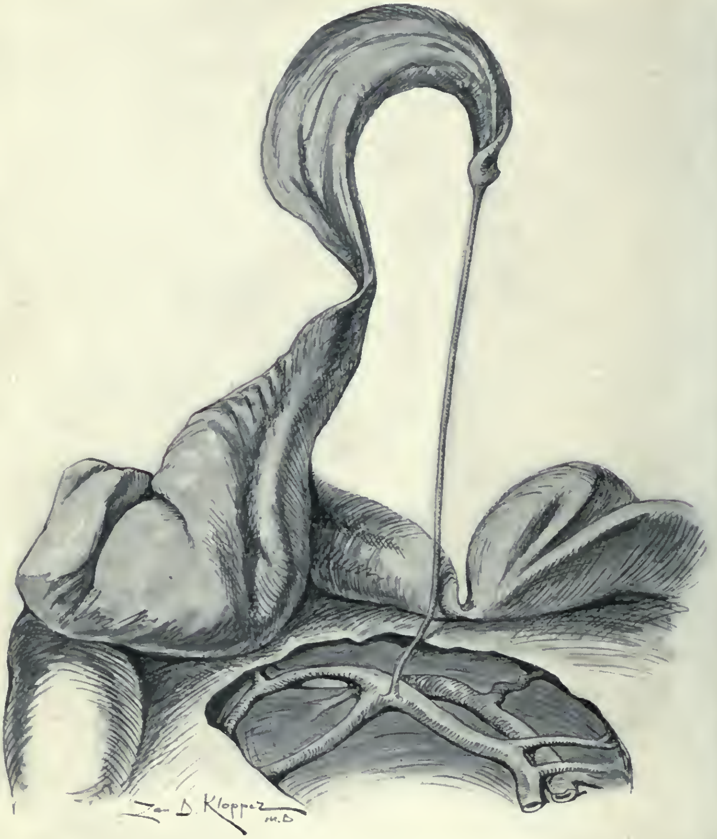
Attachments of the Terminal Ligament or Vascular Cord.—The fibrous cord or band by which the diverticulum is attached either to the umbilicus or some other structure is called the terminal ligament. This, as has just been explained, may represent the remains of the umbilical vessels which accompany the diverticulum. The normal point of fixation of the diverticulum or of its terminal ligament (which represents the obliterated portion

FIG. 2.



Meckel's diverticulum with large mesenteriolum (Boström). An opening due to atrophy is seen in the middle of the mesenteriolum. The umbilical (omphalomesenteric) vessels run along the free edge of the mesenteriolum, and empty into the mesenteric artery and vein respectively.

FIG. 4.

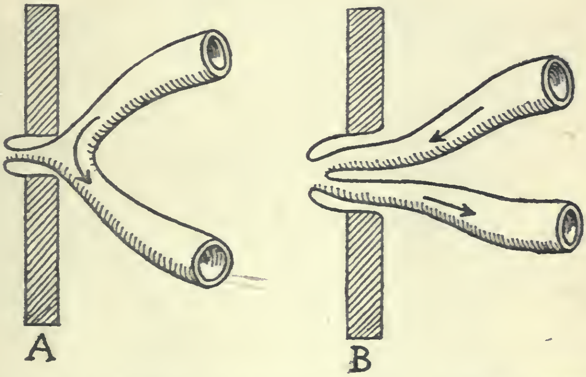


Strangulated Meckel's diverticulum complicating strangulation of intestine in narrow diverticular ring (Boström). Note the large ring formed by the diverticulum and its terminal ligament, the latter containing persistent omphalomesenteric vessels which empty into the mesenteric artery and vein respectively.

of the diverticulum or its accompanying vessels) is at the umbilicus. The frequency of this attachment to the umbilicus varies somewhat according to various authors: *e.g.*, Ketteler,[3] 21 in 89 cases; Halstead,[4] 15 in 69 cases; Treves,[5] 7 in 20 cases; Cazin,[6] 3 in 23 cases; and Newman,[7] 13 in 66 cases.

If the terminal ligament separates from the umbilicus it may attach itself at almost any portion of the abdominal cavity. The various points of attachment of the diverticulum or its terminal ligament are best shown in the accompanying figures of Ketteler [3] quoted from Wilms [8]: Mesentery 34, umbilicus 21, anterior abdominal wall 6, posterior abdominal wall 4, pelvis 5, bladder 2, cæcum and appendix 2, small intestine 11, large intestine 1, appendix epiploicæ of sigmoid 1, internal abdominal ring 1, intestine, omentum and abdominal wall combined (Fig. 1)—making a total of 89. Four cases are quoted by Neumann in which a vascular cord alone was present without any diverticulum. One can prove such a cord to be of non-inflammatory origin by demonstrating the vessels within its structure.

FIG. 5.



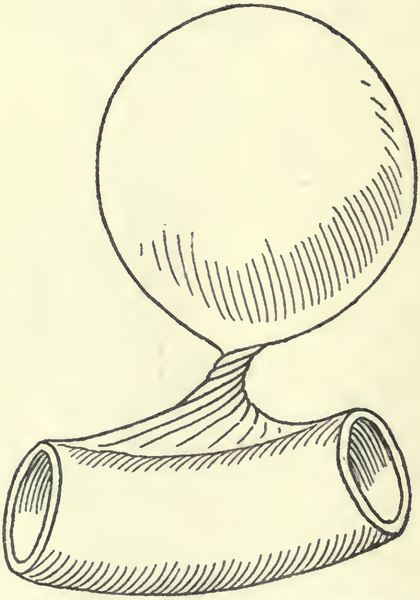
A, marked prolapse of open diverticulum at umbilicus without disturbance in passage of bowel contents. *B*, prolapse (evagination) of diverticulum causing ileus (Wilms).

The insertions of the diverticulum or its terminal ligament were found by Hilgenreiner [9] to be as follows in 121 cases: Mesentery 47, umbilicus 34, ileum 11, anterior abdominal wall 9, posterior abdominal wall 4, pelvis 4, colon, cæcum, appendix and abdominal wall 8, internal ring, bladder, urachus and omentum 4.

Point of Origin. Frequency.—Hilgenreiner[9] has collected 62 cases and found that the diverticulum arose between 20 and 100 centimetres above the ileocæcal valve. As to the frequency of its occurrence it was found 90 times in 4848 autopsies, *i.e.*, about 2 per cent. It has been found more often in males than in females, in the proportion of 86 to 14.

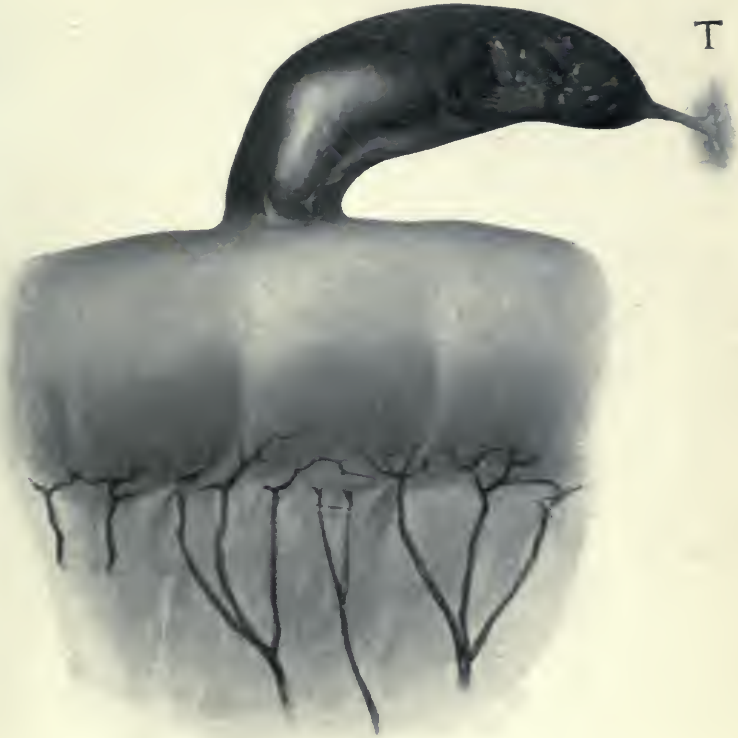
Form, Length and Frequency.—The usual form of the diverticulum is a cylindrical one with a conical tip, which is usually free. The diverticulum usually arises from the convex surface of the gut, opposite the mesenteric attachment (antimesenteric border), but it may be nearer the mesentery. The average length given by Leichtenstern[10] is from 5 to 10 centimetres, while the length found by Huntington[11] was from 1.5 to 15 centimetres. It usually leaves the gut at a right angle, seldom at an acute angle, and it may have a mesentery of varying length. The point of origin from the intestine varies from 2 to 3 feet above the ileocæcal valve.

Fig. 6.



Volvulus of a diverticulum which has been converted into a retention cyst or enterocystoma (Roth's case).

FIG. 7.



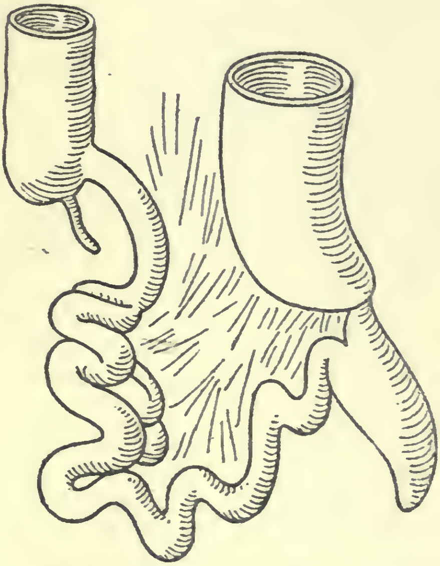
Inflamed Meckel's diverticulum adherent to adjacent mesentery by its tip. Two coils of ileum were strangulated beneath the diverticulum. *T*, terminal ligament attached to mesentery.

MECHANISM OF ILEUS DUE TO MECKEL'S DIVERTICULUM.

Certain of the anatomical conditions just described and some additional ones play an important rôle in determining the particular form or method by which ileus results from Meckel's diverticulum. These factors are:

1. *The Size and Contents of the Diverticulum.*—The diverticulum has been found to vary in size from that of a lead pencil to that of the gut,—in some instances even larger (adult head). It can readily be understood how a large diverticulum can compress a loop of gut and produce obstruction, especially if the contents are solid when the diverticulum is filled. Such an obstruction may be valve-like, depending upon the ability of the diverticulum to empty itself, so that there is a history of frequent recurrence of the attacks of obstruction.

FIG. 8.

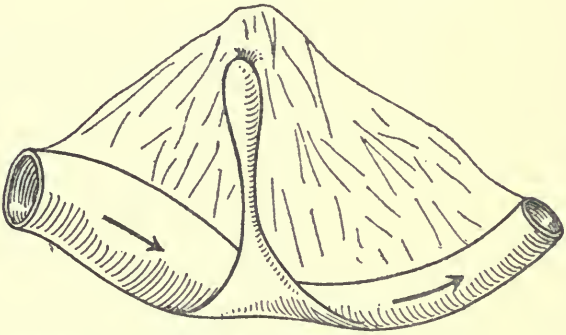


Stenosis of intestine at insertion of Meckel's diverticulum causing ileus (Good's case).

2. *The Length and Form of the Diverticulum.*—These are of importance in understanding several of the modes of pro-

duction of ileus, *e.g.*, knot formation and volvulus. If the diverticulum is free and long the chances of knot formation are very great. As will be explained later, the knot is in all probability preformed and acts in a passive manner in catching the loop of intestine (Fig. 10). As a rule, knot formation is only possible when the diverticulum is long and slender, with a knob-like or ampullar end (Figs. 10 and 11). The distal enlargement is the result of stagnation and retention of contents in a long, free diverticulum, following obstruction to the outflow of its contents.

Fig. 9.



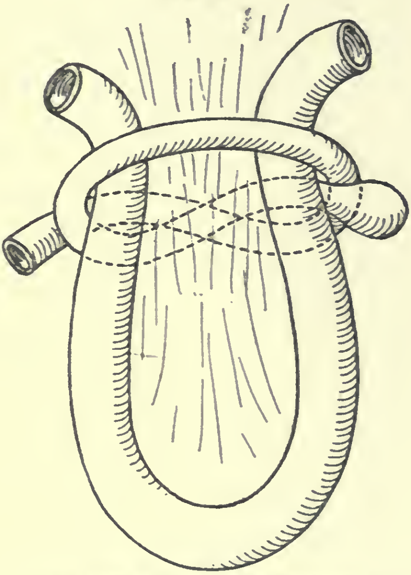
Ileus due to kinking of gut following traction of an adherent diverticulum (Hansemann's case).

3. *The Point of Insertion of the Diverticulum.*—If the diverticulum arises from some point nearer the mesenteric attachment than the middle of the convex border, a full or a short fixed diverticulum can readily cause a stenosis of the gut by traction (Fig. 8). If it arises (as rarely happens) within the layers of the mesentery, a stenosis readily follows repeated ulceration with subsequent cicatrization (Fig. 8).

4. *Whether the Diverticulum is Attached or Free.*—If it is free, obstruction depends as explained above upon its length, form, size and mode of origin from the gut. Intussusception is also more likely to occur in a free diverticulum. If the diverticulum is attached, obstruction is dependent (*a*) upon the point of attachment; (*b*) whether the diverticulum and its terminal ligament form a ring and whether this ring be large or small.

Every author who has written upon the subject of ileus due to Meckel's diverticulum has proposed a classification of his own of the mechanism. Some have based their classification upon the question of whether the diverticulum is fixed or free, *i.e.*, attached or not attached. Halstead,[4] for example, in his article upon ileus due to Meckel's diverticulum, divides the mechanism into two such large groups as follows: 1. Free diverticulum divided into (*a*) knot formation; (*b*) kinking of the intestine; (*c*) volvulus of the intestine; (*d*) stenosis of the intestine; (*e*) evagination. 2. Adherent diverticulum divided into (*a*) strangulation by band; (*b*) volvulus beneath a band; (*c*) volvulus of the diverticulum.

FIG. 10.



Knot formation by Meckel's diverticulum.

This division although convenient, is not exhaustive enough for the reason that the same mode of production of intestinal obstruction may occur in both a fixed and free diverticulum. Hilgenreiner[9] proposed a classification based upon 180 cases of Meckel's ileus which he collected. In the following parallel lists I will give the classification of Hilgenreiner[9] and Wilms,[10] and in order to assist in understanding the various mechanisms, I have added a number of illustrations from Wilms' book. The numerals after each variety in the Hilgenreiner table represent the number of cases of each group, *i.e.*, the frequency of the various mechanisms in his series of 180 cases. The grouping which has seemed to the writer to be the most logical and exhaustive one is that suggested by Wilms, and I have adopted it in this paper as the basis of the discussion of the various ways in which ileus can be produced by Meckel's diverticulum.

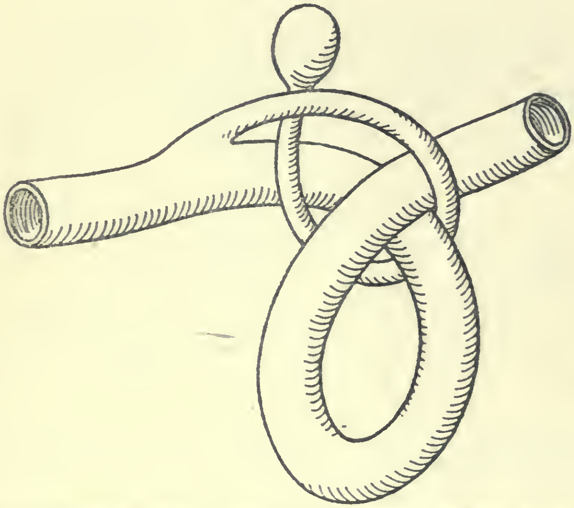
As Wilms correctly says: "A clinical classification would be far more practical than a pathological one, but it is almost impossible to make one based on such a basis." The grouping of Hilgenreiner [9] and Wilms [8] is as follows:

HILGENREINER.		WILMS.	
1. Evagination	9	1. Evagination	Fig. 5
2. Invagination (intussusception)	12	2. Invagination (intussusception).	
3. Strangulation and volvulus of diverticulum	5	3. Volvulus of diverticulum, with or without secondary volvulus of the gut	Figs. 6. 18
4. Stenosis of the intestine	2	4. Stenosis of intestine at point of attachment of diverticulum	Fig. 8
5. Kinking of intestine	19	5. Broad compression and kinking of the intestine from traction of the fixed and free diverticulum	Fig. 9
6. Compression of intestine	5	6. Included under 5 above.	
7. Knot formation	11	7. Knot formation	Figs. 10, 11
8. Volvulus of the intestine	11	8. Included under 3 above.	
9. Inflammatory closure	7	9. Included under 4 above.	
10. Strangulation by a fixed diverticulum	96	10. Strangulation in a narrow or wide diverticulum ring	Figs. 12, 13, 14
	180	11. Kinking of gut across a diverticular cord or in a ring	Fig. 15
		12. Combination of volvulus and kinking by a diverticular ring or cord	Fig. 16

From the above it will at once be seen that the mechanism of ileus due to Meckel's diverticulum is far from being a simple matter. No single mode of production holds true for all cases, and it is only after a careful study of the subject that one can have a clear conception of the more complicated forms.

Evagination of the Open Diverticulum.—The first evidence that a diverticulum remains as an open tube adherent to the umbilicus shows itself about four to five days after birth (as soon as the umbilical cord has sloughed). If the external opening is large, fæces escape; if it is quite minute only mucus is discharged. If the gut wall pushes itself like a spur into the diverticulum (Fig. 5) to an extreme degree, complete obstruction occurs and the symptoms of ileus rapidly appear. Of the seven cases of this variety collected by Barth, all died.

Fig. 11.

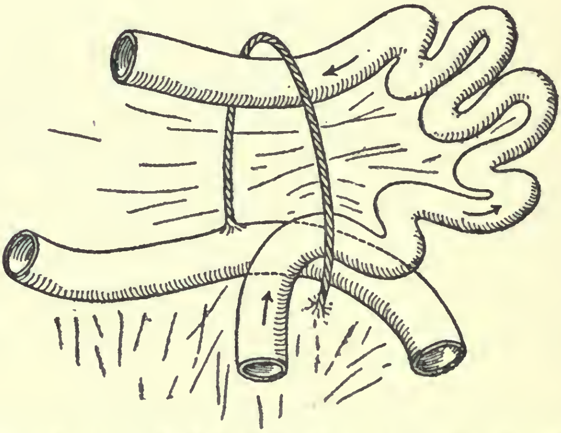


Ileus due to coil of intestine distal to insertion of diverticulum slipping into diverticular knot (Heiberg's case).

If the normal obliterative changes of the diverticulum are interfered with it may (*a*) remain open at the umbilical or at the intestinal end or at both, or (*b*) individual portions may persist and develop into cystic or solid tumors of benign character. The manner in which such a cystoma of the diverticulum can produce ileus through compression and traction is referred to later (see broad compression of the gut by the diverticulum and kinking of the gut by traction of the diverticulum). Such an enterocystoma is found lying free within the abdominal cavity, remaining attached to the gut only by a cord (Fig. 6), the cyst itself often gravitating to the pelvis.

Intussusception of Meckel's Diverticulum.—Only twelve cases are reported of this mode of production of ileus. There are two varieties, (*a*) invagination of the diverticulum alone, or (*b*) invagination of the diverticulum and gut. Undoubtedly the majority are the result of the effort at expulsion of some foreign body from the diverticulum. The clinical signs are like those of ordinary intussusception, viz., a sausage-shaped tumor, blood in the stools, vomiting and collapse.

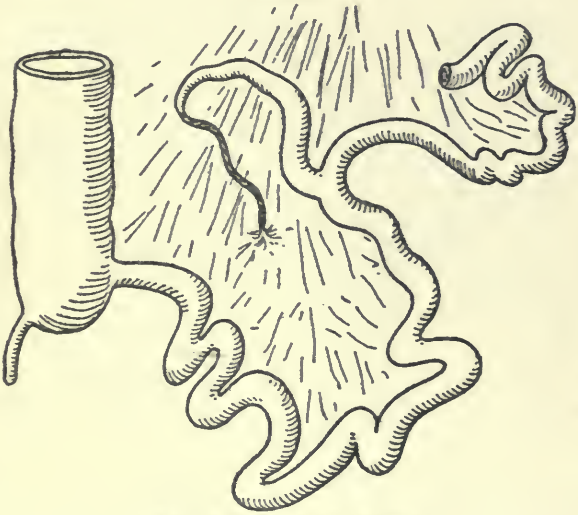
FIG. 12.



Narrow diverticular ring (Wilms) causing strangulation of gut. The diverticulum is almost completely obliterated and the ring is chiefly formed by the vascular cord.

Volvulus of the Diverticulum and Possible Secondary Volvulus of the Gut.—As a rule, the diverticulum acts in a passive manner in the production of all of the different varieties of ileus due to it. A volvulus of the diverticulum is not uncommon, the causes varying somewhat. In a free diverticulum its weight and size play a role, the lighter intestine being able to change its position more readily than a heavy free diverticulum, so that the latter may become rotated upon its axis. The same holds true for the fixed diverticulum, the variation in the amount of gas and fluid within it causing a change in its position, with resultant torsion at the point of insertion into the gut (Fig. 18). The volvulus of the diverticulum may only be accompanied by the signs of an acute diverticulitis, viz., pain, rigidity, nausea and gradual onset of the signs of peritonitis. As a rule, if recovery ensues without operation, adhesions form which encroach upon the lumen of the gut. The symptoms of ileus may, however, appear in an acute manner if the lumen of the gut is closed, through the torsion of the diverticulum being transmitted to the adjacent gut (Fig. 18).

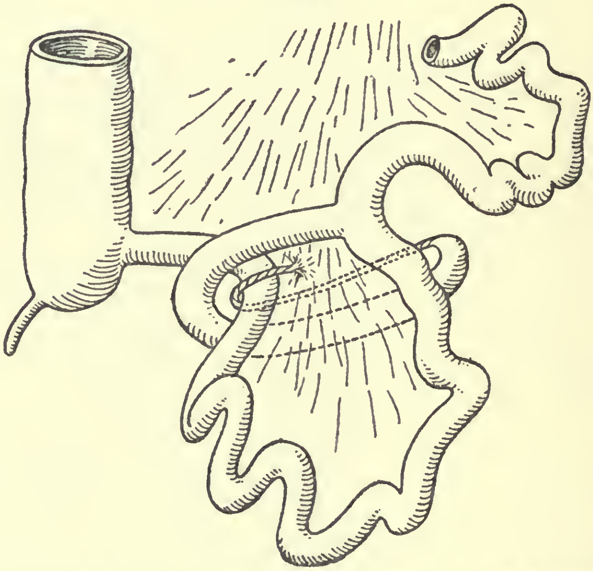
Fig. 13.



Wide diverticular ring (Wilms).

Attention may be called at this portion of the subject to two facts in relation to diverticular ileus; first, that an attack of diverticulitis as in the case to be reported by the writer (Fig. 7) may precede and obscure the signs of ileus in the early hours of an attack; second, that the condition of the diverticulum must always be considered in the diagnosis and operative treatment of cases of ileus due to Meckel's diverticulum. We must not forget that ileus due to strangulation by this structure is different from that due to any other form of band or aperture constriction, because the diverticulum is a portion of the gut itself and possesses all of its properties, viz., gangrene, perforation, volvulus formation, etc. Gangrene of the diverticulum may be found in Meckel's ileus when (*a*) the diverticulum undergoes rotation; (*b*) it is compressed by a coil of gut which has become strangulated beneath a fixed diverticulum, or (*c*) by a loop of gut suspended across it (Fig. 4), or (*d*) by traction. The sequelæ of such a necrosis of the diverticulum are either adhesions, abscess formation or perforation with general peritonitis.

FIG. 14.

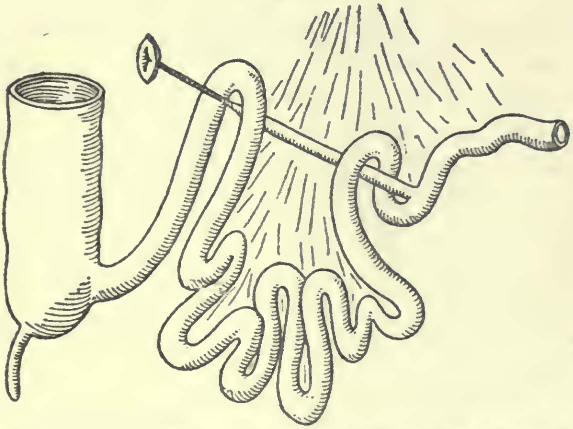


Strangulation in a narrow diverticular ring (Wilms). The ring was quite large at first, but as a result of the slipping of one coil below and one above the diverticulum, the wide ring becomes converted into two narrow ones.

Stenosis of the Intestine.—This is best explained by assuming that the diminution of the size of the lumen or its complete obliteration, which usually occurs above the insertion of the diverticulum, is the result of repeated injury of the diverticulum followed by ulceration and cicatrization of the gut in the vicinity of the diverticulum. Treves has called attention to the manner in which such damage occurs. When a large free diverticulum is full it cannot follow the movements of the intestines, so that the latter exert traction upon the point of insertion of the diverticulum, leading to abnormal kinking, so that the fecal current is slowed, leading gradually to ulceration and stenosis (Fig. 8).

Broad Compression of the Gut by the Diverticulum and Kinking of the Gut Due to Traction of the Diverticulum.—Cases of broad compression are quite rare, the case of cystoma (Fig. 6) described under evagination which compresses the intestine belonging to this class.

FIG. 15.



Ileus due to kinking of the intestine from traction across an adherent diverticulum (Wilms). Note how the afferent and efferent loops of the bowels hang across the diverticulum like a shawl carried upon the arm.

In the second group such cases are included in which kinking of the gut takes place at the diverticular insertion through traction exerted by the diverticulum. Such traction, with its resultant kinking, seldom occurs when the diverticulum is free, and can only take place under the latter condition when the diverticulum is large and full and thus resembles a fixed diverticulum. As a rule, kinking due to traction by a diverticulum most often occurs when the latter is fixed. Such a case is shown in Fig. 9, where the diverticulum was adherent to the mesentery. When the gut above the diverticulum becomes acutely filled the gut is easily kinked through traction of the adherent diverticulum.

Knot Formation.—The three conditions which are essential in the production of knot formation by a Meckel's diverticulum are (*a*) that it should be free, *i.e.,* non-attached; (*b*) that its end be knob-like, *i.e.,* ampullar (Fig. 10), and (*c*) that the diverticulum must be a long one. The mechanism of the process of knot formation is best understood by a study of Figs. 10 and 11. Some writers believe that the diverticulum acts in an active manner like a rope, in whipping itself around a loop of gut and ensnaring it. Other writers, and these form the majority, think that the knot is preformed, *i.e.,* it acts in a passive manner and the bowel slips into it. The latter view is held by Leichtenstern and Wilms. At first only a small portion of the gut is caught, but as the result of peristaltic action more of the intestine enters, and this does not cease until the more fixed portion close to the cæcum checks any further entry. There are but few genuine cases of true knot formation on record. Figure 11 shows a typical case of it reported by Regnault. Two cases of double knot formation have been recorded. The clinical features of knot formation are the rapid onset of ileus symptoms with fixed pain in the right lower quadrant.

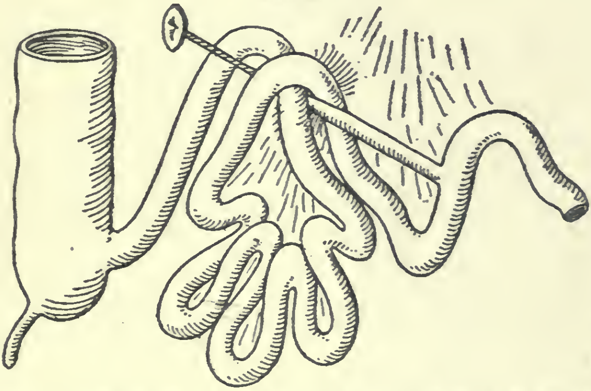
Strangulation in a Diverticular Ring or by a Diverticular Band.—There are two types of fixed Meckel's diverticula. The first form is where the diverticulum passes across the peritoneal cavity as a cord, being composed partly of tissue resembling that of the intestine and partly of tissue which shows no traces of it, viz., connective tissue. This form is shown in Fig. 12 and the various points of attachment, *e.g.,* umbilicus, mesentery, etc., have been previously mentioned. In the second form the diverticulum with its accompanying omphalomesenteric vessels forms a ring. (Figs. 2 and 20.) In this second group the diverticulum may be either fixed or free and the ring itself may be large or small (Figs. 4 and 13).

Strangulation in a Narrow or Wide Ring.—If an opening exists in the diverticular ring, even though it is quite small, a coil of intestine may slip through it,—in fact, a large, *i.e.* wide, ring is less apt to catch a coil of gut than a narrow one (Fig. 12).

In the case of a wide ring, the vessel cord and diverticulum become twisted in such a manner that a second or smaller ring is formed, though which strangulation occurs as shown in Fig. 4. This does not occur nearly as often as when the diverticulum and its vessel cord form a figure of eight.

Ileus Due to a Coil of Gut Being Kinked Across a Diverticular Cord or in a Diverticular Ring.—In this form of Meckel's ileus the coils of intestine hang across the diverticular band like a shawl laid across an arm (Fig. 9). After obstruction takes place, more and more gut is pulled across until the cæcum is reached.

FIG. 16.



Ileus due (*a*) to kinking (the result of traction from a coil riding astride an adherent diverticulum) and (*b*) to volvulus of the obstructed loop (Wilms).

Combination of Volvulus and Kinking by a Diverticular Ring or Cord.—In the case shown in Fig. 18 there may be a combination of volvulus of the diverticulum plus strangulation due to kinking of the coils which have fallen across the band. The obstruction may be only temporary, and many of these cases give a history of recurrent colics accompanied by vomiting and distention, all of which rapidly disappear until a new attack occurs. The intestine itself may also be twisted as it hangs across such a diverticular band. In some of these cases peritonitis sets in early, due to gangrene of the diverticulum, as explained previously. The same form of ileus can exist in diverticular rings as in bands due to an adherent diverticulum.

In the case shown in Fig. 13 the ring had a large lumen. It was too wide to hold the loop of gut, but the latter may fall across the ring, becoming kinked, as in Fig. 15. Under these circumstances torsion may occur at the base of the diverticulum, with resultant necrosis or chronic inflammatory processes (the latter leading to stenosis of the gut). A terminal ligament alone may act like a diverticulum in causing kinking or strangulation.

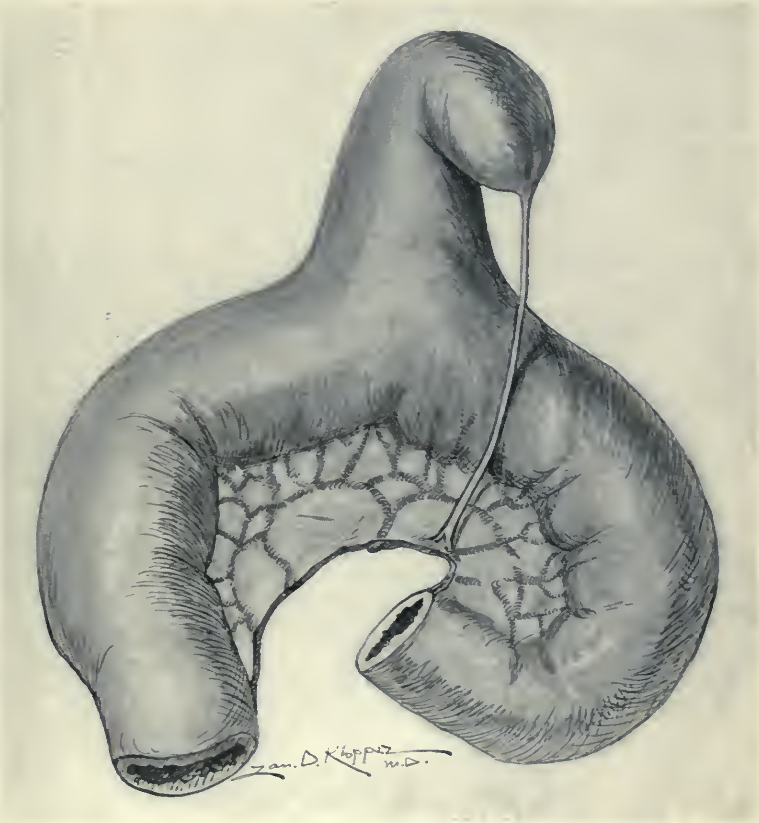
If the gut is tightly caught beneath a band, as in the author's case (Fig. 20), the gut wall necrosis occurs far more slowly than does that of the diverticulum.

The writer's case belonged to the last named group, viz., strangulation beneath a narrow ring. The diverticulum itself showed quite advanced inflammatory changes, as will be seen from the drawing (Fig. 7), made very shortly after operation. The tip of the diverticulum was attached through its terminal ligament to the mesentery, and beneath this ring two coils of ileum had become strangulated. The history of the case is as follows:

Sophie B., aged 22, married. Had always enjoyed good health until three months prior to the onset of the present illness. At that time she had an attack of "crampy" pain in the centre of the abdomen, with vomiting. The pain and discomfort lasted three hours, but disappeared without any other symptoms developing. She had remained well until 27 hours before admission, when she began to have another attack of pain in the umbilical region. Six hours later she had an attack of vomiting which lasted ten minutes. There was no chill. The pain was distinctly localized at the umbilicus.

Upon admission to my service in the Michael Reese Hospital on May 27, 1909, examination revealed the following: The patient lay in bed with her knees drawn up. There were moderate abdominal distention and marked rigidity of both recti muscles, especially upon the right side.

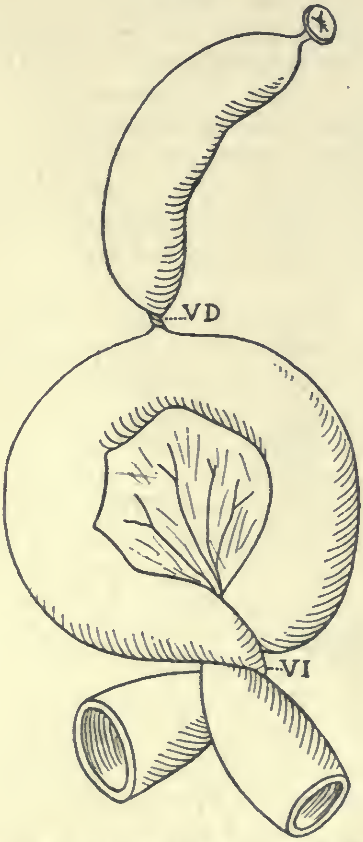
Fig. 17.



A frequent form of Meckel's diverticulum with fibrous cord (terminal ligament) which usually contains the omphalomesenteric vessels (Wilms).

Exquisite tenderness was present over the right lower abdominal quadrant, and upon moderate pressure the patient complained of pain in the umbilicus. The temperature (rectal) was 101; pulse 96. Bimanual vaginal examination was negative. Leucocyte count 19,200. On account of the well-localized rigidity, tenderness, pain and vomiting, the diagnosis of acute appendicitis was made and operation advised but not consented to until the following morning. An examination of the abdomen just before operation showed a considerable increase of the distention and more diffuse rigidity.

Fig. 18.



Gangrene of diverticulum due to volvulus of diverticulum (*VD*) accompanied by volvulus of adjacent (*VI*) intestine (Elliott's case).

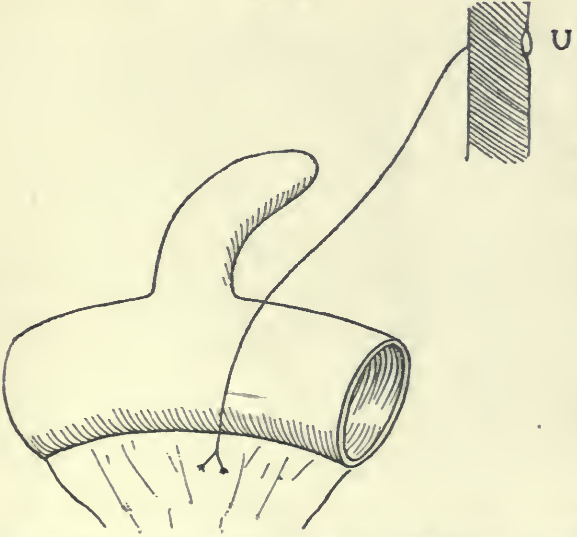
It was thought that in all probability a perforation had taken place with resulting general peritonitis. She had vomited for 18 hours prior to admission but did not vomit during her stay in the hospital prior to operation. Efforts to secure a bowel movement during her brief stay in the hospital (12 hours before operation) had been unsuccessful. Her temperature just before operation was 100 degrees; pulse 99.

Upon opening the peritoneal cavity, through a right rectus incision, a considerable quantity of clear serous fluid escaped.

The appendix was brought into the wound and found perfectly normal, with the exception of moderate injection of the vessels of the serosa. Upon retracting the edges of the incision, a number of coils of small intestine presented which were seen to be greatly distended, their serosa somewhat roughened and vessels markedly injected. From these appearances and the normal condition of the appendix, a search was made for the source of the supposed peritonitis.

Upon further examination of the presenting coils of small intestine, a number were found completely collapsed, so that it became evident that an obstruction must be present and that our previous diagnosis of beginning peritonitis was erroneous. The ileum was carefully inspected, beginning at the ileocæcal valve, and the cause of the ileus found to be an intensely congested, bluish-red Meckel's diverticulum (Figs. 7 and 20) situated about 60 cm. (24 inches) above the ileocæcal junction. This diverticulum was 8 cm. (3¼ inches) long and about 2 cm. wide at its base, tapering gradually toward its tip which was held firmly to the mesentery by a short terminal ligament. Several loops of ileum were strangulated beneath this ring, the portions distal to the constricting diverticulum being greatly distended and those upon the other side being collapsed (Fig. 20). The short terminal ligament was ligated and the coils of intestine released. The terminal ligament was divided between two ligatures and the strangulated loops released. Examination of the latter showed a distinct constriction ring which was of a grayish color, but evidently not deep enough to give rise to any danger of perforation, so that resection of the strangulated loops was deemed unnecessary. The diverticulum (Fig. 7) arose from the antimesenteric border of the gut and the ileum at the point of insertion was narrower than the portion above and below it. An incision was made around the base of the diverticulum and the latter removed after ligation close to the base. The edges of the ileum were united by a double row of Lembert sutures. The serosa and mucosa of the diverticulum showed intense congestion, but unfortunately the specimen was placed in strong formalin solution soon after removal, so that it was impossible to make any satisfactory sections for microscopical study. The patient made an uneventful recovery and left the hospital two weeks after operation.

FIG. 19.



Separate free diverticulum and adherent vascular cord (Wilms). The vascular cord which is made up of the omphalomesenteric vessels runs separately from the diverticulum, from the mesentery to the umbilicus, being attached to the umbilicus while the diverticulum itself is free.

Résumé of a Case.—Young woman of 25, with a history of an attack of umbilical pain and vomiting three months prior to present illness. Sudden recurrence of pain in umbilical region, with signs of acute inflammatory nature (rigidity, tenderness, etc.) in the right lower quadrant of abdomen. Vomiting for first 12 hours of present attack, not present after that. Diagnosis before operation, acute appendicitis, with probable incipient general peritonitis. Operation revealed strangulation of two coils of lower ileum by inflamed Meckel's diverticulum adherent to mesentery. Ligation of terminal ligament, removal of diverticulum. Recovery.

The previous history, examination upon admission, and the operative findings show clearly that the attack three months previously was in all probability similar to the present one, but less complete and only transitory. The signs of intestinal obstruction were obscured by those of the diverticulitis, so that the diagnosis of appendicitis seemed a plausible one. The mechanism of the obstruction was of the type described as strangulation under an adherent diverticulum or by a diverticular cord (Fig. 12).

Symptoms and Diagnosis of Meckel's Ileus.—Unless one can obtain a history of an umbilical fistula which existed during infancy, but has healed, or an open diverticulum is still present, it is impossible to make a diagnosis of a Meckel's diverticulum being the specific cause of the ileus in a given case.

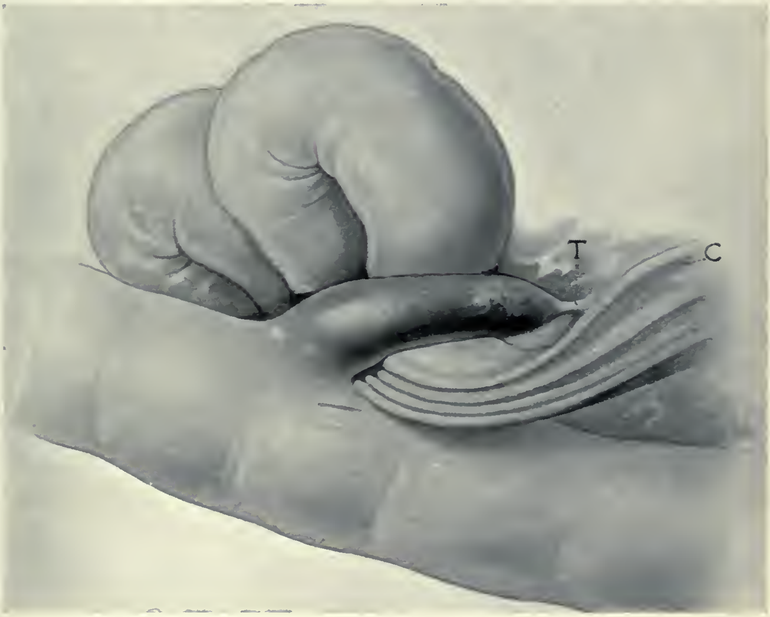
In every other respect than the two just mentioned (healed umbilical fistula or open diverticulum) *there are no signs which stamp this form of ileus from that due to any other cause.*

As a rule, the onset of the symptoms of obstruction is sudden, but in a number of cases there is, as in my own, the history of one or more previous attacks of ileus. As to age and sex, we have a little help in the fact that diverticular ileus occurs more frequently in men than in women, and most often during the first three decades.

In 138 cases Hilgenreiner found this cause of ileus in 113 men and 25 women, *i.e.*, 82 to 18. In 137 cases he found that more than two-thirds occurred in the first three decades, and of these the majority were between 15 and 25. It is quite rare above the age of 40.

In a number of cases the fact that the pains were referred to the umbilicus was thought to be of value in determining the cause of the ileus. But these umbilical pains are so constantly present in appendicitis that many cases like the writer's are erroneously diagnosed as appendicitis. In the section upon the mechanism of this form of ileus attention was called to the fact that the condition of the diverticulum itself must be taken

FIG. 20.



Strangulation of two coils of ileum beneath an attached Meckel's diverticulum. *T*, terminal ligament attached to mesentery. *C*, collapsed coils of ileum (semidiagrammatic).

into consideration in every case of ileus due to this cause. The diverticulitis so often accompanying these cases will cause the same symptoms, viz., localized pain, rigidity, tenderness, leucocytosis, fever, etc., as a genuine appendicitis and thus obscure the clinical picture until the symptoms of ileus—whether of the obturation or strangulation type—become more prominent and finally predominate.

The signs of intestinal obstruction do not differ from those which are due to other causes than Meckel's diverticulum. In some the course is somewhat protracted, varying with the degree of obstruction. In other cases the course is of the fulminating type, the vomiting, abdominal distention, obstipation, etc., following each other very rapidly. If a stenosis of the gut due to a stricture be the cause of the obstruction, the symptoms are very slow in their onset, the repeated colics, occasional vomiting, visible peristalsis and obstinate constipation differing but little from the clinical picture as seen in other cases of enterostenosis of the more chronic type. When the abdomen has been opened the diagnosis becomes a much simpler problem, as a rule. There are, however, cases in which repeated attacks have given rise to such dense adhesions that it is difficult at first to determine the cause of the obstruction.

The surgeon should be thoroughly familiar with the various modes of obstruction caused by Meckel's diverticulum in order to properly correct the condition underlying the ileus.

Treatment.—Ileus due to Meckel's diverticulum is equally as clear an indication for operation as that due to any other cause, *e.g.,* volvulus, strangulation by a band or aperture, intussusception, etc. The operative technic differs in only a few minor details from that employed in the treatment of other forms of intestinal obstruction, and in this connection I cannot too strongly emphasize the importance of early operation and of an accurate knowledge of the various modes of production of ileus due to Meckel's diverticulum.

The best incision for all varieties of ileus is one in the median line below the umbilicus. Undoubtedly many cases are operated upon, as in the writer's case, for a supposed appendicitis through a right rectus incision, and this may be a fortunate error.

If one suspects a Meckel's diverticulum before the operation as the cause of the ileus, the right rectus incision is a very convenient one, since it permits a rapid survey to be made of the lower ileum. No hard and fast rules can be laid down as to the operative technic in cases of ileus in general, and of this variety in particular. Much depends upon the length of time which has elapsed since the obstruction was complete. The amount of distention of the coils of intestine, the condition of the strangulated or obturated coil or coils in regard to gangrene, etc., and, finally, the general condition of the patient, are all additional factors which influence the methods to be employed.

In general, it may be said of this as of the other forms of ileus, that the more conservative the procedure if the patient's condition is bad, and the more rapidly the operation is performed, the better will be the result.

A certain routine is necessary after opening the abdomen. In cases of ileus of the variety described in this paper the lower ileum is usually found collapsed, so that search should be begun for such empty coils at the ileocæcal valve and the gut passed rapidly through the fingers until the point of obstruction is reached. As few coils of intestine as possible should be brought out of the abdominal incision. It would seem to be superfluous to mention this, were it not for the fact that operators are apt to underestimate the amount of shock resulting from prolonged exposure and handling of coils of intestines, even when covered with hot towels. A minimum degree of eventration is easily attained if coils are returned into the peritoneal cavity as soon as they have been inspected. As soon as the cause of the obstruction has been found in the form of a diverticulum or a vascular cord, the attachments to the mesentery (Fig. 20) or to some other structure, *e.g.* umbilicus, etc., should be severed between double ligatures.

If the diverticulum is free this step is of course unnecessary. After ligating the terminal ligament in an attached diverticulum, the latter is removed by making an incision around its base close to the junction with the ileum through the serous coat, as was done in the writer's case, and ligating it without permitting bowel contents to escape. The opening in the ileum is now closed either by a purse-string suture of silk, reinforced by a row of Lembert sutures, or—as some prefer—a double row of Lembert sutures.

The treatment of the complicated forms and sequelæ of a Meckel's ileus does not differ from that incident to any other cause of ileus. If the coil of intestine is gangrenous as the result of the circular constriction within a diverticular ring (Fig. 20), resection is indicated, if the condition of the patient warrants such a step.

If, however, the coils of intestine are distended and the general condition is not good, an enterostomy is the safest procedure. This temporary fistula can be readily closed or the gut at this point resected when the patient has recovered from the immediate effects of the toxæmia due to the ileus. The method of resection is largely a matter of choice, but the writer prefers the suture method rather than the use of any device.

What has just been said of Meckel's ileus due to strangulation within a ring, knot, etc., holds equally true for those forms of obstruction due to occlusion of the gut without strangulation. In other words, after a ring or terminal ligament or vascular cord have been severed, or a volvulus untwisted, the question of resection, enterostomy, etc., depends again upon the condition of the gut and of the patient.

The general tendency of the majority of surgeons at the present time is toward an enterostomy in all cases of ileus if the patient's condition is not such as to permit of more radical measures. In regard to the results of operation in ileus due to Meckel's diverticulum, statistics even of a large number of cases are of little value, since much depends upon the day of the obstruction and the variety of ileus (obturation or strangulation) as well as upon the judgment of the operator.

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DIFFUSE PERITONITIS.*

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It is with a sense of satisfaction that we can approach the subject of Diffuse Peritonitis. While it is still one of the conditions much dreaded by the surgeon, recent great strides in its treatment founded upon the firm basis of clinical experience and pathological investigation give ample grounds for the hope that in time in may become a disease in which our prognosis can be almost always favorable.

The pathology and course of peritonitis is that of inflammation as modified by the special anatomical and physiological characteristics of the abdominal cavity and its organs. It is only upon the basis of a thorough understanding of these characteristics that we can found any rational mode of therapy.

The peritoneum forms a serous sac of very irregular shape and of an area approximately as great as that of the skin. It is a closed organ,—that is to say, the stomata or stigmata described by the older writers have been found to be artefacts or evidences of the peculiar staining qualities of the membrane. In the diaphragmatic zone, however, an extraordinarily close relation exists between the peritoneum and the lymph current through the medium of lymphatic arches, which approach the peritoneal cavity so closely that only the most delicate membrane intervenes, and this mechanism is regarded as a special device for the absorption of foreign particles from the peritoneum into the lymphatics. Such an absorption, and a very rapid one, has been experimentally demonstrated.

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But far more important from our standpoint, than either the extent or minute structure of the peritoneum, is its remarkable power of absorption. It is quite immaterial for our purposes to decide whether this be primarily through the vascular system or by means of the lymphatics. It is this absorptive power or action of the peritoneum which renders infection of that membrane so dangerous to the organism as a whole. Moreover, foreign bodies—and especially bacteria—are taken up in great quantities by the peritoneum in an incredibly short time.

The absorptive power of the peritoneum is not uniform throughout. It has been demonstrated that the diaphragmatic area absorbs most rapidly and the omental area stands next in this respect. The parietal and visceral areas play an entirely secondary rôle in absorption. The pelvic zone is the least absorptive of all, thus accounting for the comparative ease with which infections in this area, as those arising from the tubes and ovaries in the female, are withstood.

Murphy in his recent article on peritonitis has called particular attention to the influence of the mechanical action of the diaphragm in promoting absorption through the peritoneal surface covering it, and has compared the suction excited by the opening and closing of its lymphatics to the action of a pump. Such a supposition would help us to explain the very great absorptive power in this region.

The whole clinical picture and course of acute peritoneal infection or acute peritonitis depends upon this absorptive power of the peritoneum. It is impossible to conceive of any lesion in which the discrepancy between the constitutional symptoms and the immediate damage locally is greater.

For practical purposes we may say that peritonitis is always caused by bacteria. Simple mechanical peritonitis is largely of academic interest, while the existence of a special form of aseptic chemical peritonitis, aside from that caused by experimental introduction of irritant solutions or the rare escape of sterile physiological fluids into the abdominal cavity, is no longer considered as playing any part.

The ideas of Tavel and Lanz, that the peritoneum is free of micro-organisms because the fluid gives no culture, have been reversed by the finding on the surface of the bowel or omentum numerous bacteria in cases where cultural examination of free fluid in the abdominal cavity showed nothing, and which were therefore formerly regarded as cases of aseptic or chemical peritonitis.

Even that form of mild reactive inflammation seen about extravasations of blood has been shown by Dudgeon and Sargent to be due to an infective process set up by the staphylococcus albus. These observations we have been able to confirm in the laboratory of the German Hospital of Philadelphia, though we have not found the staphylococcus with such regularity as have these observers. Thus it is seen that even those cases which were previously considered as undoubted instances of chemical peritonitis must often be placed in the infective group.

Infecting micro-organisms gain entrance into the abdominal cavity in the following ways: (1) From infection arising within the peritoneal cavity. (2) By direct extension of infection through the parietes. Examples of this method are peritonitis by extension through the diaphragm from an empyema or lung abscess, or from suppuration of the internal abdominal ring due to ascending infection from the epididymis, or by extension of puerperal infection through the walls of the female pelvic organs. (3) By way of the blood stream. (4) Through a penetrating wound of the abdominal walls.

The mechanism of the first two methods is comparatively simple and examples are relatively infrequent.

Hæmatogenous infections also come but rarely to our clinical notice and their mechanism is not as well understood. Peiser has recently concluded, as a result of experimental work, that bacteria circulating in the blood do not enter the serous membranes so long as these are uninjured; but be the membranes ever so slightly irritated or inflamed, the circulating organisms very quickly gain a foothold. It depends on the virulence of the organisms and the individual resistance what results come from the bacterial invasion. He found that the presence of even such mild fluids as normal salt solution or sterile bouillon in the abdominal cavity was sufficient to excite an invasion by bacteria subsequently injected into a vein.

Occasionally we encounter clinical instances of peritonitis in which we can find no intra-abdominal lesion or portal of entry, and we are forced to conclude that the infection was hæmatogenous in origin. In the cases of primary pneumococcus peritonitis which have multiplied so rapidly of late, the causal organism certainly gained entrance in many instances through the blood from a distant pneumococcus infection such as pneumonia, otitis media, etc.

From a practical standpoint, however, this avenue of infection fades into insignificance when compared with (fourthly) peritonitis derived by direct infection from diseased intra-abdominal organs. The appendix, the pyloric region, the internal genitalia of the female and the gall-bladder are responsible for over 95 per cent. of all cases of peritonitis, and it is the knowledge of this fact which more than anything else gives us a substantial basis for diagnosis and treatment.

The bacteria which can excite a peritonitis are numerous, but ordinarily we find certain organisms recurring with great regularity. The colon bacillus is by far the most common, though its ability to overgrow other organisms in culture media doubtless gives it a statistical importance beyond its deserts. A smear from the pus will often reveal the presence of a mixed infection even where it is impossible to isolate by culture any organism except the colon bacillus. Pfeiffer, working in the laboratories of the German Hospital, by culturing the surface of actively inflamed appendices in an early stage has found a considerable percentage showing the pyogenic cocci, albus, citreus and aureus. Later, through the portal of entry thus made, the ubiquitous colon bacillus makes its appearance and often assumes a leading part.

Dudgeon and Sargent ascribe a special importance to the staphylococcus albus, having found it the first to appear and the last to disappear in peritonitis. They found it in the early stages of diffuse peritonitis and in the region about the advancing edge of more severe infections. They recovered it from the clot in practically all cases of intra-abdominal hemorrhage and from the surface of the bowel in many cases of intestinal obstruction. From the findings combined with the results of experimental work they assert that the staphylococcus albus is practically nonpathogenic under these conditions, and, indeed, exercises a protective function by inducing a mild antecedent inflammation of the peritoneum which better enables it to withstand the attack of subsequently arriving organisms of higher virulence. We have been unable to find the white coccus with such regularity, but our observations are as yet too few to be conclusive.

Murphy names the organisms of most importance in accordance with their order as follows: The colon bacillus, the streptococcus, the pneumococcus, the bacillus pyocyaneus, the typhoid bacillus, the gonococcus and the staphylococcus pyogenes aureus.

The streptococcus is relatively more important in women than in men on account of the frequency of the streptococcic infections of the pelvic organs. Thus McDonald found it 18 times in 41 cases of diffuse peritonitis in females. The peculiar difficulty of isolating this organism from mixed cultures undoubtedly fails to give it due credit for its frequency. Pfeiffer has repeatedly seen undoubted streptococci in stained smears from peritoneal exudate, though painstaking search failed to reveal them in culture. When in pure culture or in puerperal infections the streptococcus is particularly fatal.

Pneumococcic peritonitis is more common in children and in females than in males. It has a marked tendency to become encapsulated. Pneumococcic peritonitis following perforation of viscera is more common when the rupture occurs in the stomach or duodenum than in the lower part of the intestinal tract, perhaps on account of the frequent presence of the pneumococcus in the sputum which has been swallowed.

The exudate in this form is quite characteristic, being odorless, of a yellowish green color, rather gummy in consistency, at first turbid and with a limited number of flaky coagula in it, later becoming thicker and more characteristically purulent.

The anærobic bacteria, for which much was claimed by French observers, have not been accorded much pathogenicity by more recent workers.

We must ever bear in mind that the bacteriology of peritonitis itself is often very different from the bacteriology of the process to which it owes its origin, and in this respect we are in much the same position as the clinician not so many years ago when his ideas of living pathology were being drawn from post-mortem findings.

The first means of defence of the peritoneum against infective agents within is absorption. I have pointed out that a mechanism does exist for the absorption of inert particles or bacteria, and the extraordinary rapidity with which this takes place is well shown by the experiments of Buxton and Torrey and verified by many others. They found that typhoid bacilli or particles of lampblack injected into the peritoneal cavity of a rabbit passed through the diaphragmatic lymphatics into the mediastinal lymph-nodes and thence into the thoracic duct and blood stream in five to fifteen minutes after infection. The omentum also aids materially in the process. The inert particles or bacteria are rapidly entangled upon its surface by a fine fibrinous deposit and at once taken up by phagocytic cells which, then, either digests them *in situ* or carries them into the deeper tissues.

Thus, insoluble particles are absorbed either in a free state or after they have been englobed by phagocytes. They are taken up exclusively by the lymphatics, while soluble substances pass into the blood directly as well as into the lymph vessels.

But failing absorption, the peritoneum can still wage a valiant battle within. Injurious agents quickly set up an outpouring of serum which contains antibacterial, antitoxic and opsonic bodies and phagocytic cells. Buxton and Torrey found that typhoid bacilli injected into the peritoneal cavity of a rabbit, provided that the dose was not too large, were rapidly destroyed. The immune substances of the serum at once poisoned the bacteria, so to speak, causing death and granular disintegration. This effect often occurred so rapidly as to receive from the experimenters the name of explosive destruction. This was not always an unmixed blessing since the rapid liberation of endotoxins was sometimes sufficient to cause fulminating toxæmia and death of the animal. If, however, this primary toxæmia was not overpowering, the impending danger of implantation of infection upon the peritoneum was averted. These experimenters point out that the so-called shock which carries off many patients in the early hours after operation may be due to this explosive destruction of disseminated bacteria and the liberation of their toxic products in overwhelming dose into the circulation. This is a strong argument against the dissemination of infective material by operative or other means, and renders the practice of flushing out the abdominal cavity of very doubtful propriety.

In addition to the serous exudate, there is very rapidly deposited upon the peritoneum, under the influence of irritants, a very fine and at first invisible film of fibrin. This serves to ensnare the bacteria and render them susceptible to the action of phagocytes, which takes place much more satisfactorily when the phagocytic cells are allowed to move over a surface than when they float in fluid. The cells chiefly concerned in engulfing the particles are the macrophages, or cells of the peritoneal fluid, though it is found that in order to dispose effectively of the bacteria there must be in a short time a considerable response of the microphage cells from the blood.

Even in case a portion of the peritoneum is irrecoverably damaged, Nature frequently comes to the rescue by throwing about that area such a wall of protective exudate, at first fibrinous and later organized, that the general cavity is protected.

To what extent one can trust this spontaneous exclusion of dangerous areas has caused some of the most animated controversies in abdominal surgery, and to this point I shall return in the consideration of treatment.

Other things being equal, infections beginning from the margins of the peritoneal cavity are less dangerous than those beginning centrally, because of the greater dangers of diffusion of sepsis in the latter case. Also those which arise in the upper zone are more serious than those arising lower, on account of more rapid diffusion and greater activity of absorption in the diaphragmatic area.

The type of organism and the individual resistance are important with regard to the outcome but are fortuitous factors which can be but little influenced at the present time by the efforts of the physician. Probably we shall hereafter learn to employ specific serotherapy to second our other efforts, and already we have cases in which such treatment has seemed productive of good results.

The rapidity with which infectious material is let loose within the cavity and its amount are of great importance. This is the same as the question of dosage which is so important in experimental work. A slow escape of organisms gives time for complete absorption or for defensive adhesions. Such a condition we often find about a chronically diseased appendix, gall-bladder or Fallopian tube, or about slowly advancing ulceration of the stomach, or, less frequently, of the ileum in typhoid fever. A more rapid escape may give rise to a local peritonitis which has in its smaller sphere all the pathological features of general peritonitis, differing only in extent, the infection being overpowered before generalization. This may terminate in the production of adhesions or may leave a residual abscess such as we find in certain cases of appendicitic or subacute perforation of the stomach.

Foreign material, such as food, fecal matter, bile, pancreatic juice, urine or cyst contents in the various disruptive accidents within the abdominal cavity, or extraneous substances introduced into the abdomen through its external wall greatly increase the chance of the bacteria obtaining a foothold.

It is certain that any procedure which favors the spread or diffusion of infection from the point of entrance is highly inexpedient and, *per contra,* whatever hinders diffusion and assists in localization is desirable. Our aim is therefore to minimize diffusion. This is the foundation stone of rational preliminary or palliative treatment, and our postoperative methods must be consistent with it.

Intraperitoneal diffusion results from the operation of discoverable factors, many of which may be greatly influenced by appropriate measures. It is true that we are able to influence but slightly the tendency to diffusion by capillarity or by virtue of the increase of fluid and the motility of organisms, as well as the spread of infection which takes place by way of the subperitoneal lymphatics; these are constant disadvantages under which we labor but fortunately are not the chief ways by which diffusion is increased.

The experimental work of Meisel and Yates has permitted a definite formulation of some of the principles, the operation of which we recognize clinically.

Both Meisel and Yates observed increased diffusion as the result of general bodily activity and diaphragmatic movement, and they both found that the influence of posture and of gravity in draining noxious fluids to the lower and less dangerous portions of the cavity was most marked when general bodily respiratory and peristaltic movements were diminished to a considerable extent. It is obvious then that rational treatment must be directed toward the inhibition of those physical and physiological activities which aid in diffusion and toward the removal of any source of continued infection. We utilize this knowledge in a practical way when by drainage and posture we encourage the gravitation of infected peritoneal fluids to the lower and less dangerous portions of the peritoneal cavity.

The recognition of peritonitis itself is usually not difficult. The determination of its origin often gives great difficulty. The previous history is most important, since a knowledge of the prior existence of disease of an intra-abdominal organ frequently directs our search for the source or confirms our ideas derived from the present attack and the examination. Thus, a history of antecedent gastric disturbance is of great aid in the diagnosis of perforating gastric or duodenal ulcer, and in its absence the case is almost invariably diagnosticated as perforative appendicitis. Dr. William E. Hughes succeeded in recognizing an early case of perforated duodenal ulcer, which he referred to me, by the aid of a previously undescribed sign in this condition, viz., the demonstration of the presence of both gas and fluid in the abdominal cavity by means of the metallic tinkling obtained by tapping two coins together over the air space in much the same manner as is done in pneumothorax. The patient was operated upon fourteen hours after perforation and made an uneventful recovery.

In women a history indicative of uterine or tubal infection is significant, and the importance of a history of typhoid, dysentery, or trauma is too obvious to require more than mention.

However, so great is the preponderance of cases due to disease of the appendix, the gall-bladder, the pyloric region, or the internal genitalia, that in the vast majority of instances we are able to make a diagnosis, with considerable certainty, from the consideration of a single attack together with the physical examination.

The recognition of the existence of peritonitis is, as I have said, in the majority of cases relatively easy. It is ushered in by pain, usually general, but tending at some time to point by location to the seat of the infecting process. Thus in gastric, duodenal or cholecystic disease the pain is apt to be high up in the abdomen or in the back, while in pelvic or appendiceal disease the pain is usually felt in the pelvis or lower abdomen, although with a long appendix inflamed at the tip the pain may be greatest wherever the tip happens to lie. With fulminating peritonitis, the general involvement of the peritoneum may be established before the period of general pain subsides, thus increasing the difficulty of the diagnosis. This is quite often the case in perforations of the stomach, duodenum or gall-bladder.

Immediately following the onset of pain there is practically always nausea and usually vomiting.

Reflex rigidity of the abdominal muscles, with tenderness upon pressure, which is generally greatest over the source of the infection, are early and constant signs.

Pain, vomiting, and rigidity form the diagnostic triad. There are however other signs of considerable importance. The facies; the posture, the pulse, the increasing distention, the regurgitation and vomiting of the later stages: all the clinical manifestations have been acutely observed from the time of Hippocrates, and we can scarcely hope to add to the many lucid and vigorous pictures which have been drawn.

It is well known how greatly this picture may be distorted in the presence of typhoid fever. The benumbed sensorium and disturbed metabolism do not respond in the same way as does the healthy individual. We are usually made aware of the occurrence of some intra-abdominal catastrophe, but we must not expect typical symptoms. It is often announced by sudden, sharp abdominal pain, but often there is no more than abdominal distress, and the pain, when sharp soon moderates and may completely disappear. Thus the first member of our diagnostic triad is weakened.

Nausea and vomiting are more often absent than present. The second member of the triad forsakes us.

Rigidity is often slight or entirely masked by the presence of the tympanites. Thus our third mainstay is taken away.

Our chief reliance however must be pain or distress. Without it we shall hardly recognize a case of perforation in time to be of service. If with this we now observe a marked change in the patient's condition; a rising pulse and respiratory rate with a fluctuation of temperature up or down, with any abdominal tenderness and change of tension of its wall, exploration should not be deferred. The leucocyte count is of little value, if any, in the initial diagnosis, and to wait for movable dulness in the flanks and obliteration of liver dulness is to lose the patient.

Mr. Moynihan, in his address on Inaugural Symptoms (*British Medical Journal,* Nov., 1908) has called attention to the fact that in the early stages of perforative peritonitis collapse and the rapid pulse are absent. He has also shown the value of noting the rigidity of the abdominal muscles and especially of the diaphragm, as shown in short, "catchy" respiratory movements.

In other forms of peritonitis the value of the leucocyte count and especially of the differential estimation has received considerable attention of late. Taken in conjunction with the clinical aspects, as indeed all laboratory results must be, they are of distinct service. I have learned that a low leucocyte count in the presence of a manifestly severe peritoneal infection is of gloomy prognosis. Such a state of affairs might occasionally induce me to defer operation until a rising count and general improvement should denote increased resistance.

Provided there is a high leucocyte count, I do not regard a high polymorphonuclear percentage with the alarm manifested by some. But if this is added to an already low count it should increase one's apprehension.

Conditions to be differentiated are intestinal obstruction, acute pancreatitis, ruptured ectopic pregnancy, pneumonia and diaphragmatic pleurisy, acute gastro-enteritis, Dietl's crises, mesenteric thrombosis and the visceral crises of tabes, purpura, and the erythema group of skin diseases so well portrayed by Osler. It is scarcely possible for me here to give a practical discussion of the differential points to be considered in distinguishing these diseases. Their symptomatology is readily accessible and the chief point is to bear them in mind. I wish to emphasize one fact which has been pointed out by Bloodgood and is I believe too little appreciated by the profession, namely, the constancy of a leucocytosis in intestinal obstruction before the onset of peritonitis. For those who advocate delay in grave cases of appendiceal peritonitis to consider a severe case of obstruction as one of peritonitis by reason of a high leucocyte count is a fatal error; this mistake has occurred.

The treatment of diffuse peritonitis constitutes the most important problem of abdominal surgery, and the great advances which have been made in the treatment of this disease during late years have resulted from a combination of early operation and attention to details. It is hard to keep more than one aspect of a question prominently before the profession at the same time, and the active discussion and improvements of the detailed treatment which have been going on during the last three or four years have partially diverted attention from the necessity of quick action. Therefore, in connection with the uniformly good results to be obtained by means now at our disposal, when brought to bear within the first few hours, I wish also to emphasize their frequent futility in the later stages. Peritonitis early is practically a different disease from peritonitis late.

It is a mistake to begin the consideration of treatment with operation, since the pre-operative conduct of a case is so important with regard to the success of any measures taken later.

The first sign of oncoming peritonitis, or even of a condition known frequently to give rise to it, should be the signal for the institution of anatomical and physiological rest of the intra-abdominal organs, and particularly the gastro-intestinal tract. I have pointed out the importance of intra-abdominal diffusion and the factors which produce it. By rest and quiet in bed we diminish respiratory activity and the motion of the intestines consequent upon general bodily movement.

The important factor of peristalsis we seek to control by withholding all nourishment by mouth, solid or liquid. The general practice of giving a purge for abdominal pain should be discouraged, since it favors the most potent physical factor in the dissemination of sepsis. So many cases of gastrointestinal derangement respond readily to this simple treatment that a false analogy has been drawn in regard to its applicability in the early stages of appendicitis and other acute surgical conditions within the abdomen. To purge these cases is contrary to reason and common sense, and every surgeon has observed that those cases that have been actively purged are in general more severe.

The use of morphine, or opium derivatives, in the treatment is to be most strongly condemned. Before operation it deceives both physician and patient and may be the cause of operative delay. It retards peristalsis, but the good effect in this respect is overcome by the increase in intestinal retention, in this manner adding another factor of toxic absorption to that already great enough. Moreover, opium has been found to diminish leucocytes, and thus in another way to act against the protective forces of the body.

The postural treatment should be begun at once. Not only are vicious fluids thus drained to the least dangerous portion of the abdomen, but the omentum—the abdominal scavenger and organ of phagocytosis—is aided to seek the site of the lesion. If the patient must be transported to the hospital, as is most often the case, he should be maintained in a semi-sitting position in the ambulance. The posture should be maintained if possible during the operation and until convalescence is established. Attention has been called to cardiac weakness as a contraindication to the position, but personally I have not observed it.

Cold applications to the abdomen are grateful and perhaps serve to diminish peristalsis and absorption. A useful by-effect of this application is that it helps to keep the patient quiet and also discourages too frequently meddling examinations after the diagnosis is made.

The peritonitis patient needs water. He is bled into his splanchnic vessels by their reactive dilatation, and fluids are still further withdrawn by their increasing accumulation in the lumen of the intestine and in the abdominal cavity. The general bodily tissues are dehydrated. This is the message which the body seeks to tell us by the small-volumed pulse and the pinched Hippocratic facies. Yet if we give water by mouth we excite peristalsis which, we have seen, favors diffusion of septic materials and hinders exudative exclusion of the focus of infection. On the other hand, if the infection be severe enough already to produce paresis of the bowel, the water is unable to reach the large intestine, in which the absorption of fluids takes place. In this manner so far from accomplishing our object of re-filling the depleted vessels we not only fail in this but also add to the accumulation of fluids in the bowels and increase distention. The general bodily functions are depressed by the lack of their normal fluid contents. The bone marrow, in which are elaborated many of the products antagonistic to infection, is under a disadvantage in this production. The kidneys, deprived of their normal amount of blood and working under low secretory pressure cannot eliminate the deleterious products of metabolism and infection. The heart suffers mechanically from the diminution in the volume of the circulating blood, and to this we have added the poisonous effects on all the tissues of concentration of toxins produced by bacterial growth and often by stagnation of the intestinal contents. For obvious reasons it is impracticable to supply the need for water by hypodermic or intravenous infusion. It remained for Murphy to give us a method for supplying water to the body in almost unlimited quantity. This consists in the constant administration of normal saline solution by way of the rectum. I am led to speak of this procedure at some length because I believe that it is in many cases a life-saver, and I should like to see it even more widely used and the method of administration perfected to the last detail. The normal antiperistalsis of the large bowel, demonstrated by Cannon, is assisted by the reverse mucous currents described by Bond, and the gentle onward pressure of the fluid as it enters carrying it upwards throughout the extent of the colon where fluid absorption is most active. Even the lower portion of the ileum may in some instances receive the fluid, as it has been repeatedly demonstrated that in life the ileocæcal valve is not competent to prevent regurgitation.

I began with the drop method, interrupting the flow of fluid by a pinch-cock on the tube between the reservoir and the rectum. Some time ago I discarded this for the gravity method as described by Murphy in his article in *Surgery, Gynecology and Obstetrics,* June, 1908, since we found that in this way the patient takes more fluid with less discomfort. There is less tendency to distention. The patient can pass flatus out through the reservoir, and if he strain or if the rectum contracts spasmodically the fluid contained is forced backward into the tank, thus avoiding expulsion into the bed. We have found that the simpler the apparatus the better the results. A reservoir for the saline connected by a good-sized rubber tube with a bent douche nozzle of hard rubber or glass is all that is required. The bend in the tube is for the purpose of preventing the end from being forced up into the rectum or back against its wall when the patient is in the sitting posture, since it is of the greatest importance to avoid irritation of the rectum.

Two hot-water bags about the tube, replenished at intervals and placed near the rectal end of the tube and surrounded by blankets, suffice to maintain the fluid at a proper temperature.

The level of the *top of the fluid* is a matter to be determined by experiment in the individual case. Usually an elevation of six to twelve inches above that of the rectum is best. Increasing distention and rapid flow of the saline are indications to reduce the height, while cessation of flow should induce an increase of elevation. The pressure of the fluid must be slightly greater than the intra-abdominal pressure.

The whole matter is easy if attention to detail be given, and uniformly good results will be obtained. It is often well to give a cleansing enema before beginning the continuous proctoclysis, and daily during its administration. If absorption be slow or fecal matter be expelled back through the tube, an enema will often promote comfort and enable absorption to be resumed with renewed vigor.

Under this treatment the whole appearance and condition of a patient is rapidly changed. The face loses its pallor and pinched appearance, and as the blood pressure mounts the pulse fills out and the general condition of the patient soon improves; so that I have come to regard the classical small wiry character as a quite inconstant accompaniment of peritonitis. Drainage from the abdomen, where drainage tube or gauze has been inserted, becomes more profuse and watery, the bodily functions proceed under more favorable conditions, elimination is increased, and the patient often rapidly passes out of danger. The method is applicable both before and after operation, though its greatest usefulness is as a post-operative adjunct.

In our enthusiasm for new methods we should not overrun contraindications. In this instance there seem to be remarkably few. I have seen a few cases in which I thought abdominal distention and discomfort were increased. Proper methods of administration will almost always obviate this, but it has occasionally seemed of advantage to stop the saline flow at longer or shorter intervals.

I have several times seen puffiness of the eyes and slight œdema of the legs with the passage of very large amounts of urine; and have questioned whether the patient was not receiving too much fluid. I would regard such an occurrence as an indication to slacken the administration. This leads to a consideration of whether salt in such large quantities may have any deleterious effect upon the kidneys or the organism as a whole. Certainly the thorough flushing with large amounts of fluid more than counteract any ill effects, but I would advise cutting down the salt content to as small a percentage as is consistent with a bland non-irritating quality of the fluid. Very material increase in the quantity of urine passed is an indication that the saline is being well absorbed.

Finally, I may say that I have tried a number of contrivances for automatically delivering into the rectum saline at a constant temperature, but have not yet been convinced of their superiority or even of their equal merit with the simple method I have indicated when controlled by a nurse of experience. Small quantities of predigested beef solution or sometimes whiskey are advantageously added to the saline for nourishment or stimulation.

Though we hail with delight such useful adjuncts in treatment, after all, the most important single factor in the successful treatment of peritonitis, however caused, is early operation.

The Murphy method of administering saline or any other method of treatment naturally is valuable primarily as an adjunct to operative interference. No one can question the propriety of operation. We must determine, however, the best time for operation in each individual case, and the method of procedure after we do determine to enter the abdomen.

The great factor in success in dealing with diffuse or generalizing peritonitis is that of time. Early operation means success, late operation probably failure. If we are able to relieve the intra-abdominal tension, remove the toxic material and close the avenue of infection within 48 to 50 hours, our chance of success, using all the modern methods of after-treatment, is as 30 to 1.

After fifty hours the mortality gradually increases until it reaches, with a few days delay, a point at which a large percentage of cases become of necessity fatal.

Last year Murphy reported a series of 51 cases of diffuse peritonitis of varying etiology with but two deaths. All these cases were operated on within forty hours from onset. Murphy does not give his experience with cases of spreading or generalized peritonitis operated on at a later period, but who can doubt that the mortality would mount rapidly beyond that extremely low figure for early cases.

To these statistics I can add those of 118 cases of my own, of diffuse peritonitis all of appendiceal origin, with the exception of seven cases due to perforation of stomach and duodenum.

DIFFUSE PERITONITIS OF APPENDICEAL ORIGIN.

Duration.	Cases	Recovered	Died	Mortality per cent.
Under 40 hrs.	63	62	1	1.5 per cent.

Only those cases were chosen which exhibited at the time of operation macroscopic evidence of wide peritonitis with free purulent exudate and no limiting adhesions. In addition to the macroscopic evidence of diffuse peritonitis I have required that a culture taken from the exudate at a distance from the appendix, the focus of infection, should yield pathogenic organisms. This latter requirement, on account of the absence of a culture, has ruled out a number of cases which should from their pathology be included in the tabulation. It has seemed best to do so, however, in order to avoid a possible objection that cases showing only a sterile exudation had been included. Many cases of acute appendicitis operated within 24 hours of the onset of the attack show free fluid in the peritoneum at the site of operation, and in the pelvis, which to the naked eye looks purulent, but culture of the same is negative; all such cases, of which we have a number, have not been included in this compilation. Many of these I close without drainage. The great difficulty in distinguishing by inspection a septic exudate from a sterile reactive fluid which is innocuous or even defensive is well known.

As nearly as possible we have tried to estimate duration from the beginning of severe symptoms denoting involvement of the peritoneum. We do not hold that our diagnostic acumen is sufficient to compass this desirable end with mathematical accuracy; still we feel sure of a reasonable approximation.

Deaths from septic pneumonia, cardiac exhaustion, septic endocarditis, pulmonary embolism, secondary obstruction, subdiaphragmatic and pulmonary abscesses have been included without comment though peritonitis was not present at autopsy, since we think it proper to reckon the mortality from the standpoint of the whole disease rather than to try to eliminate those cases in which the peritoneum recovered itself.

In the last 55 cases of general peritonitis in which I have used continuous saline treatment, there have been 12 deaths, all of which were in cases of over fifty hours duration.

In the last group are included all cases of general peritonitis of appendiceal origin in which any operative intervention was attempted. In a number of this group of cases practically moribund at time of operation, nothing more than a suprapubic puncture and tube drainage under nitrous oxide anæsthesia were done.

It is readily seen that the total mortality of such a collection of cases means practically nothing. We attempt nothing more than to show the prognosis of diffuse peritonitis at different periods as treated by operative and rational postoperative methods. Every series of statistics compiled in a way to show the influence of early operation in reducing the mortality shows the same striking result and they could be quoted in great number. In perforated gastric and duodenal ulcer Brunner and Tinker found the result almost invariably bad after the eleventh hour. Miles, in 46 cases found the operative mortality within the first 12 hours only 26.3 per cent.; in the next 12 hours, 44.4 per cent., in the third 12 hours, 50 per cent., and after that 91.7 per cent. Our own experience at the German Hospital in this class of cases, which, true, have been comparatively few, has been most unusual, no deaths.

So far as appendiceal peritonitis is concerned it is evident that if treated by operation within the first forty hours after perforation, or even within the first fifty hours, it has become in experienced hands a condition associated with a comparatively low mortality.

The alarming rise in mortality which ensues after passage of the fifty-hour line casts a perilous responsibility upon the man who wishes to keep a case long under observation or to try palliative measures first.

It may be objected that many cases which show early free peritonitis will, under proper treatment, localize the infection and become more favorable surgical risks. I have too great respect for the defensive powers of the body as a whole, and the peritoneum in particular, to deny that this is possible. And I doubt very much whether the mortality of late operation will be less, even in the fortunate event of localized abscess formation, than we now have in early operations. Moreover, I do not by any means grant that all cases will proceed so fortunately. Certainly some cases will fail to exclude the infective focus and go on to general peritonitis and death. It is interesting to note in this connection that I had in this series 92 cases under fifty hours with a mortality of 3.2 per cent.

The foregoing remarks concerning immediate operation refer to cases within the first forty to fifty hours after the onset of the diffuse peritoneal involvement. Every case seen during that time should be operated upon, barring unusual and extraordinary complications or features.

When we come to consider cases of peritonitis after the first fifty hours following the onset of the peritonitis a more serious problem confronts us,—as has already been stated cases of diffuse peritonitis are most liable to succumb within two or three days or else they live almost a week. The question therefore arises, shall we treat the cases after forty or fifty hours as we do those before?—that is to say, by immediate operation, or are some of them to be treated expectantly in the hope that they will either recover or that intervention at a later period will give us better results?

I believe it to be impossible, at least it is for me, to always differentiate between a diffused and a diffusing peritonitis, or a localized peritonitis with diffusing peritoneal irritation, or between a diffuse and general peritonitis. The physical signs may seem to indicate that the whole peritoneum is involved in the inflammatory process, yet upon operation we discover that the infection is localized and that there is a widespread accompanying irritation. On the other hand, all of us have seen cases in which there was apparently only a local process, whereas operation or autopsy disclosed a peritonitis practically invading every nook and corner of the abdominal cavity. I do not mean to say, however, that the differential diagnosis between the conditions mentioned cannot be made in many of the cases which come to our notice. Upon careful study and examination we can, as a rule, formulate in a fairly clear manner a correct opinion as to the intra-abdominal lesions present. In the exceptions, however, *i.e.,* those in which we cannot make such a definite diagnosis, the difficulties in the way of determining the proper course of procedure are vastly increased. In the class of cases under discussion, having made up our mind to operation, when the patient is relaxing under the anæsthetic palpation may reveal a different condition than before anæsthesia and thus lead to a different conclusion. Palpation must be made very gently, as I have known an abscess to be ruptured by the surgeon being too strenuous in his efforts to form a positive conclusion. The area of abdominal muscles immediately overlying the lesion is the last to relax.

Broadly speaking, the cases of true diffuse peritonitis more than fifty hours old, which come to our notice may be divided into two classes.

In the first class we may include those cases in which the patient shows a good resistance to the disease. The temperature will be elevated, but not excessively so, the pulse rapid but of fair volume and tension. In all forms of peritonitis rigidity is one of the earliest signs. In appendiceal peritonitis it is usually associated with distention unless the spasticity of the muscles at first is so great as to preclude this. In peritoneal irritation or inflammation of the upper abdomen such as that caused by the perforation of a gastric or duodenal ulcer, the rigidity is one of the earliest signs and abdominal distention does not come on until several hours later. In the type of disease under discussion we note, however, the absence of cyanosis and of a leaky skin—indications that the infection is getting the upper hand. The leucocyte count is fairly high and the polynuclears present in high percentage. In other words, we have every evidence that the patient has not been overwhelmed by the initial toxæmia, but on the contrary that the body resistance fairly equalizes the infection.

In such cases as these the surgeon is safe in delaying operation until all the evidences of an acute inflammatory process have subsided, that is to say, until the peritonitis has become subacute, stationary and without active symptoms. If the patient has been progressively improving further delay under such conditions will make his recovery more certain. As a general working rule we can say that delay is far more liable to do good than harm, and that in case of doubt we should always be more prone to hesitate than to operate.

The second class of cases is that which includes those patients who have apparently been making a losing fight against the disease. The clinical picture is characteristic. The anxious facial expression, the cyanosis with small rapid, running pulse, the leaky skin, and the enormous abdominal distention gives us evidence ~~in~~ abundance that the prognosis is a bad one. If in addition to the symptoms mentioned we have a low leucocyte count with a high percentage of polynuclears we have still further proof, if it were needed, that the defences of the body against the bacterial poisons have been almost completely overcome. It is my opinion that such cases should not be operated upon.

When such a patient is seen we should proceed at once to institute the proper medical treatment, namely: This consists of (1) absolutely nothing by mouth, (2) ice to the abdomen, (3) continuous proctoclysis by the method of Murphy (4) avoidance of morphia, except for the plainest indications of mental distress or uncontrollable restlessness (5) the semi-erect position (6) lavage of the stomach.

My aversion to morphia is not based on any theoretical pros and cons. I cannot say therefore whether the depression of such peristalsis as still exists with consequent liability to meteorism, the inhibition of leucocytosis or the lowering of general metabolic activity and functions are the unfavorable results of a routine morphia treatment, but merely that it has seemed to me to work adversely in these cases:

I am accustomed to add about 100 c.c. of predigested beef to the litre of saline by way of alimentation about every four to six hours.

It is impossible to formulate definite rules for the treatment of peritoneal inflammation. A consideration of the treatment of diffuse peritonitis involves also that of the conditions which precede it or resemble it. The most prevalent cause of peritonitis, such as we have under discussion, is appendicitis, and we may use the peritoneal sequelæ of an acute appendicitis as typical cases.

It will be agreed that all cases of appendicitis with the inflammation confined to the appendix should be operated immediately.

When the disease has progressed beyond the appendix we may have one of several conditions:

(1) A strictly localized abscess without signs of diffusion and without peritoneal irritation is a condition for immediate operation.

(2) A localizing abscess with diffuse peritoneal irritation is as a rule more safely treated by waiting until the active peritoneal inflammatory symptoms have subsided. It must be remembered, however, that there may be leakage from a weak abscess wall and that this can give rise to a severe form of diffuse peritonitis, therefore a percentage of this type of cases should be operated in the presence of peritoneal symptoms.

(3) A circumscribed peritonitis with a diffuse peritoneal irritation. In these cases, we often have practically the same symptom complex that is shown in an established diffuse peritonitis. When such a process is at its height it is often impossible to say whether we have really a diffuse or a circumscribed peritonitis.

My practice in these cases, when ill more than forty to fifty hours, as to operation depends upon the presence or absence of some definite localizing sign of the original seat of the peritonitis. When the patient's abdomen is uniformly rigid or uniformly distended and I cannot detect any point of excruciating tenderness in the right iliac fossa, flank or loin, and the appendix cannot be located in the pelvis by rectal or vaginal examination, I do not operate, I treat such cases by the Ochsner method supplemented by proctoclysis as practised by Murphy.

As soon as a well-localized area of rigidity and tenderness is well marked and the evidence of peritoneal irritation is practically subsided, operation offers a much greater percentage of recoveries than in the stage immediately preceding this condition.

The situation of the localized focus is of importance. We may have it toward the flank, loin, or pelvis, and then localization and disappearance of peritoneal irritation will be much more rapid and complete than when it is toward the median line. In fact, in the latter instances delay is absolutely essential.

In peritonitis of the upper abdomen our course of procedure must be somewhat different, depending upon the source of the lesion. To make myself thoroughly understood I will individualize.

Peritonitis due to gastric, duodenal, intestinal perforation, rupture of the gall-bladder, liver or spleen must be operated as soon as the patient is seen if any chance of recovery is to be offered.

Acute peritonitis due to pancreatitis should not in my judgment be subjected to immediate operation if the best results are to be obtained, nor peritonitis the result of gall-bladder inflammations excluding rupture of the healthy organ, gangrene and ulcerative perforation.

Peritonitis of the lower abdomen, other than that due to appendicitis and acute pyosalpinx, should be operated at the earliest possible moment to obtain the best results. In cases of less than forty-eight hours duration we operate immediately.

Operation.—Very much depends on the anæsthesia, which must be carefully administered. There must be no struggling to increase operative difficulty, retard the speed of the operator or to spread sepsis.

The surgeon may overcome in a measure the increased operative difficulty by a proper incision. The best incision is one which affords immediate exposure of the area to be attacked and is large enough. Better too large than too small. An incision through the semilunar line is usually better than a muscle splitting incision, as it is possible thereby to avoid the vice-like grasp of the spastic recti or flat muscles. The pathology must be quickly recognized and proper action determined without unnecessary exploration and evisceration. If, on opening the peritoneum, pus gushes out, I make it a practice to insert a glass tube in the pelvis and thus remove much of the fluid before inserting the gauze packs. I believe that this procedure minimizes the chances of spreading the infection.

I have found that the introduction of gauze packs at this stage to wall off the general cavity from the site of operation, introducing them to just beyond the site of the lesion, is of great assistance. It precludes the escape of the distended loops of gut upon the soiled field of operation. As a rule the pus immediately surrounding the source of infection is more foul and dangerous than that at a distance. By the proper arrangement of gauze the chances of diffusion of this foul pus are at least minimized. Every step under control of the eye can be more swiftly and accurately performed with less danger of engrafting a mixed infection upon that already existing. The slight trauma to the peritoneum attendant upon the careful placing of these pads is, I believe, a negligable factor when contrasted with the advantage derived. The condemnation expressed by some operators in regard to this procedure is readily convicted of being nothing more than opinion unsupported by fact. The uniform recovery of cases treated in this manner when under the time limits I have pointed out is sufficient rebuttal.

The objects of surgical intervention may be considered under three main headings, viz.: (1) The primary lesion.

(2) The products of inflammation or leakage. (3) Intestinal paresis.

1. First the exciting cause of the condition must be sought out and remedied. Simple laparotomy and drainage will very rarely materially influence the result. In desperate cases not permitting formal procedures I have frequently attempted a palliative puncture and drainage but, with rare exceptions, have never observed any good effect. Indeed, the evacuation of large amounts of pus and relief of tension have often had a diametrically opposite effect. In cases where the operation was really nothing more than a paracentesis under momentary gas anæsthesia I have seen the temperature begin to mount at once and in the course of a few hours the patient would succumb. This effect is so different from that usually ascribed to relief of tension that I confess some doubt in regard to the cause. It would appear that absorption is in some way hastened, whether through the small avenue of the fresh puncture, which I think highly unlikely, or through reactively dilated vessels of the peritoneum I am unable to say.

In general those organs which admit of ready removal, viz., the appendix, the gall-bladder, the Fallopian tubes, Meckel's diverticulum and infected cysts, when they are the starting point of the process, should be removed entire. Perforations of the bowel can usually be repaired in such a way as to preserve its continuity.

In a word, the primary focus must be so treated as to insure a discontinuance of its furnishing septic products to the peritoneal cavity, which may be done by complete removal, by repair or by excluding it from the general cavity.

2. Concerning the disposal of the products of inflammation or leakage there is no general agreement, and we find men of great experience and excellent judgment advocating the most widely different methods of procedure and quoting statistics which vary greatly in support of their views. Free general irrigation, local irrigation, wet sponging, dry sponging and no irrigation all have their strong adherents.

Concerning the use of antiseptic solutions for irrigation, both clinical and experimental work prove that they do more harm than good, and they have rightly been generally abandoned. Those who irrigate almost universally recommend normal salt solution, relying entirely on its mechanical cleansing effect.

Though my results have been incomparably better since I abandoned the irrigation treatment about five years ago, my methods have perhaps changed so much in other respects as to render the figures valueless from a controversial standpoint.

There are certain extensive collections of cases which seem strongly to support the view that irrigation is harmful rather than beneficial.

Murphy quotes Harte and Ashhurst's tabulation of 200 cases of typhoid peritonitis, as follows:

HARTE AND ASHHURST'S TABULATION.

	Cases	Recovered	Died	Mortality
Drainage, not wiping or irrigating	17	10	7	41 per cent.
Wiping and draining	31	12	19	61 per cent.
Irrigation and drainage	176	46	130	74 per cent.
Wiping, irrigation and drainage	11	1	10	90 per cent.

He points out that it is remarkable to note how each additional procedure adds from 15 to 20 per cent. to the mortality.

One year ago Nitch reported the following collection of cases of diffuse appendiceal peritonitis bearing on this point.

	Cases	Deaths	Mortality
GENERAL IRRIGATION.			
St. Thomas Hospital staff	100	80	80.
Sargent	19	18	94.7
DRY SPONGING OR LOCAL IRRIGATION.			
Morton	14	2	14.2
Sargent	6	0	00.
Burger	33	1	3.03
Nitch	30	3	10.

It is certain that in general the tendency is towards less irrigation and less sponging and on the part of those who use irrigation to restrict its use to more and more narrow limits. My objections to general irrigation may be summed up as follows:

1. It consumes time which we cannot afford to lose.

2. It certainly diffuses infectious material and the products of infection.

3. By causing us to manipulate the bowel it has a tendency to cause postoperative paresis.

4. When we use efficient drainage and methods of administering saline, irrigation is unnecessary because under these conditions the peritoneum is amply able to take care of any fluid present. When we have a peritonitis in which pus flows immediately upon opening the peritoneal cavity and is seen to come from every point within apparently, as far as one can see through the ordinary abdominal incision, it is not by any means certain that we are dealing with a general peritonitis. So that to speak of washing out a case of diffused peritonitis perhaps sounds all right, and may be theoretically all right, but practically is all wrong. A diffused peritonitis may not by any means be a general peritonitis, therefore to wash such a case means to make it general, if it is not one already. For some years I have entirely given it up and employ sponging in only those cases which show a local highly foul and purulent exudate or extravasated gastric or intestinal contents. I am convinced that it is a mistake to use it in all cases in which the peritonitis is not demonstrably generalized and complete, and under the exigencies of operation it is very rarely possible to be certain without doing more harm to those which are found not to be complete than we benefit this latter class of cases by irrigation—if indeed irrigation benefits them at all.

I have found it to be a mistake to wipe away the coating of protective lymph from the bowel. I am sure that we run a similar risk of washing out protective collections or seropurulent exudate from certain regions of the abdomen and especially the highly important diaphragmatic area, thus exposing them to infection and the body to fulminating toxæmia from rapid absorption.

As for my own method, I sop away gently whatever fluid wells up into the field of operation, and at once or after the completion of the other intra-abdominal steps of the operation I insert a perforated glass tube into the pelvis and pump out whatever fluid is found there. I do not go on any extensive tour of the abdomen hunting for exudate to aspirate or wipe away. It has been seen that much of the exudate is harmless or defensive. In many very early cases I do not drain at all,—the peritoneum will do its best work when not embarrassed. These are, however, only the cases in which the exudate is not as yet frankly purulent or in excessive quantity. Scattering infection in these fresh areas and the trauma of sponging cannot well be innocuous. I leave the glass tube in the pelvis and remove it as soon as the discharge, which is systematically aspirated, becomes clear and scanty. This takes place usually in one to three days. I do not believe it is possible by this or any other method to drain the abdominal cavity completely or to relieve tension from all its parts. Therefore, when its function, which rapidly becomes entirely local, is done, it should be removed without delay. I leave the wound open, its edges partially approximated by retaining sutures of silkworm gut. If there is dangerous necrotic tissue in the abdomen which can neither recover itself, nor yet be removed, I establish a tract down to it by means of gauze tamponade. Gauze will not drain fluids properly and has a tendency to act more as a hindrance than as an aid to their discharge. That gauze is useless for drainage after a few hours is my firm conviction and I would like to see the use of the word drainage discontinued in connection with it. When used as drainage it not only fails to drain but is a barrier to drainage and may excite dangerous adhesions between coils of bowel.

In regard to the direct operative treatment of intestinal paresis in connection with peritonitis, with its accumulations, I shall only say that I am not an enthusiast.

In all procedures the least and the most rapid work consistent with attainment of the cardinal objects is life saving.

Postoperative treatment consists mainly in "letting the patient get well." He is put to bed and kept warm. At first the head of the bed is elevated. Then when he is sufficiently recovered from ether he is placed back in the semi-erect position, which is maintained by means of pillows beneath the back and of a sling beneath the buttocks. Continuous proctoclysis is given in the manner described. Absolutely nothing is allowed by mouth so long as there is risk of increasing peritoneal irritation by exciting peristalsis; this means on an average between two, three and four days. Ice to the abdomen will help to relieve the patient's pain. For vomiting I have one remedy, the stomach tube. For distention I employ stimulant enemata, at times turpentine stupes to the abdomen, the stomach pump when the stomach is distended—as frequently happens—and eserin, hypodermically. This line of treatment will only be of use, however, when we have a simple distention. Distention due to postoperative ileus must be distinguished therefrom, and requires other measures. For cardiac weakness I usually give strychnia and digitalis. Saline hypodermoclysis is the best means to promote good action of the kidneys, but caffeine given hypodermically in the form of the alkaloid dissolved in water by the aid of sodium salicylate is at times of value. I do not persist in carrying out the exaggerated Fowler position for the length of time I did formerly. I am of the opinion that intestinal obstruction, particularly in the pelvic basin, is more likely to occur if patients are kept too long in this position; therefore, I think that the object of the position has been obtained after the first 48 to 72 hours.

For other special indications I sometimes use other measures, but simplicity is the note.

The essential treatment of peritonitis I would sum up as follows: (1) Early operation; (2) Light anæsthesia; (3) Rapidity of operation; (4) Appropriate treatment of focus of infection; (5) Avoidance of flushing and evisceration; (6) Proper drainage; (7) Simple postoperative treatment by posture and proctoclysis with predigested beef for the purpose of nutrition.

APPENDICOSTOMY IN CONDITIONS OF ACUTE PERITONITIS.

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SINCE the introduction of the operation of appendicostomy by Weir in 1902 it has been employed more and more frequently in cases of chronic disorder of the colon, and Keetley[1] has lately brought forward thirty-five cases, most of which illustrate its value in this connection. But the method also is an exceedingly useful one in conditions of acute peritonitis, especially when this has been caused by appendicitis, and in children. In some of Keetley's cases (XXII–XXV) the appendix was used "for nutritional purposes" in conditions of suppurative peritonitis. But in all these death occurred, and it is evident from the author's remarks that under these circumstances the method has not left a favorable impression. But I think that the main value of appendicostomy in acute peritonitis is rather as a means of combating shock and toxæmia than for "nutritional purposes." I suppose all surgeons are agreed in regarding the infusion of saline fluid into the tissues of the patient as the most potent means of recovery after the abdomen has been opened for acute and diffuse septic conditions. This may be done either by the veins, the cellular tissue, or the bowel. The disadvantages of direct infusion into the veins are the necessity for a separate operation and the difficulty of continuing the transfusion by this method for many hours. If the subcutaneous method be used, there is great difficulty in keeping a child still enough for its employment, and further, when a profound condition of shock and toxæmia exist concurrently, the blood-pressure is so low that the fluid finds its way into the circulation very slowly. Therefore, Murphy's suggestion of employing the bowel as the channel for infusion has been almost universally adopted. It has the great advantage of allowing the reception of fluid to continue for many hours and, further, the fluid in the course of its absorption must quicken the lymph-stream in the very area affected by the septic invasion. Thus it acts locally in flushing the abdominal tissues as well as constitutionally in combating shock and toxæmia. But here again there are very real difficulties, especially in dealing with children and those who are desperately ill. Such patients do not always tolerate the tube in the rectum well. They cry and strain, and either the tube comes out or else the fluid injected is returned into the bed. And in the case of a patient who is hovering on the brink of death the manipulations necessary to keep a watch on the rectal tube tend to their harm, inasmuch as they necessitate some movement and uncovering. For all these reasons appendicostomy offers a most ready and efficient substitute for rectal infusion, for it forms a part of the operation for opening the focus of disease which actually shortens this procedure. It can then be used either continuously or intermittently for the transfusion of fluid without in any way disturbing the patient, and, last but not least, it can be varied so as to adapt it to the washing out of the whole bowel and so getting rid of the stagnating contents of the large intestine.

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[1] Keetley: Proceedings of the Royal Society of Medicine, December, 1908.

Most of these points are so well illustrated by the following four cases that I relate them in the order of occurrence.

CASE I.—George D., aged 8, admitted to the Cossham Hospital, October 24, 1908, with abdominal pain. Two days ago he was suddenly seized with pain in the abdomen, accompanied by vomiting. His condition grew rapidly worse since the onset of symptoms. He lay on his right side with his knees drawn up, his face flushed, and vomited frequently. Temperature 101°, pulse 124, respiration 40. The abdomen was rigid all over, tender, and with no respiratory movement. No localizing signs could be felt through the parietes but definite thickening on the right side of the pelvis was palpable through the rectum. Diagnosis of general peritonitis caused by appendicitis was made and the abdomen opened at once through the right linea semilunaris. A few ounces of offensive thin pus escaped and the appendix was found to be gangrenous in its distal half. There were no limiting adhesions observed. Appendix was removed flush with the cæcum and into the appendiculocæcal orifice a small Paul's tube about one-third inch in diameter was tied. The wound was packed and brought together with two silkworm gut stitches. One pint of hot water with one-half ounce of brandy was poured in through the cæcal opening; the boy's condition became notably better than before the operation.

October 25, the general and local conditions were much improved. The temperature remained at 98.2° to 98.4° and the pulse 84 to 106 throughout the day. He had nothing given by mouth, and one-half pint of water with one-half pint of peptonized milk were given per cæcum every six hours. At 6 P.M. the temperature rose to 101°, but the pulse remained at 84 and his general condition seemed good. The wound was foul, dry, and sloughy.

October 26, at 5 A.M., the boy seemed to have some sudden seizure, crying out and jumping out of bed. From that time onwards he was only semi-conscious. The pulse rose to 120 and was very small and irregular. The temperature fell to 97°, the extremities were cold, and the face cyanosed. He died at 1 P.M.

In this case it was evident that a good recovery was being made from the grave condition of septic infection, when pulmonary thrombosis or embolism probably occurred. The method of appendicostomy was, however, a faulty one as it did away with the natural sphincter which exists at the base of the appendix and which in most cases is quite competent to prevent regurgitation.

Case II.—Alfred H., aged 6 years, admitted to the Cossham Hospital December 28, 1908, with abdominal pain. He is a thin delicate child who had diphtheria one year ago and has had a chronic cough for the last few months. One week ago he complained of abdominal pain, which was accompanied by vomiting. Both these symptoms have increased since and the bowels have not acted for three days. He lies on his back with both knees drawn up, the breathing is rapid and shallow. Pulse 144, respiration 40, temperature 98.2°. The abdomen is hard, tender, and rigid, with dulness all over the lower part. Diagnosis: diffuse peritonitis probably arising from the appendix.

Operation.—Incision made first into the *left* semilunar line, where a quantity of thin pus was discovered and a drainage tube sewn in; then into the right semilunar line through which the appendix was found. It had completely sloughed in its distal part. There was a good deal of pus free in the peritoneal cavity, which had the usual *B. coli* odor. The stump of the appendix was tied to a rubber catheter and fixed into the upper angle of the wound. The rest of the wound was packed and drained. The patient was pulseless at the end of the operation. One pint of saline was given through the appendix every two hours and half an ounce of brandy every four hours throughout the next twenty-four hours. His general condition very slowly improved. The bowels were opened twice daily, after washing through from the appendix. The tube was removed from the appendix on December 31. By January 2 his general condition had greatly improved, but the wounds looked very unhealthy, both being covered with black sloughs. From January 5–9 he had some pyrexia (102°), pain in the hypogastrium, and painful micturition. A median collection of pus was opened through a suprapubic wound and after this he made rapid progress to recovery. The appendix stump was cauterized on February 19 and healed readily. The boy was discharged on March 11. He was readmitted on March 14 for a fecal fistula over the site of the appendix stump. This was again cauterized and he has since been quite well.

In this and the two subsequent cases I adopted the plan of opening the abdomen first on the *left* side, although the case was probably one of appendicitis. The advantage of this is that if pus is not discovered the small wound can be sewn up without fear of septic contamination, whereas if such an opening is made after a foul appendix has been explored it is very difficult to avoid introducing septic material, if such is not already present. As a matter of fact in each of these three cases pus was found on both sides of the abdomen.

Case III.—Queenie S., aged 10. No previous illness. Admitted to the Cossham Hospital February 20, 1909, with severe abdominal pain. The pain had begun suddenly when at school two days previously (February 18), and on returning home a dose of castor oil was administered, which made the pain much worse in spite of the opening of the bowels. Vomiting occurred several times in these two days and three times on the day of admission.

Condition at 6 p.m.—Child was acutely ill with drawn and anxious expression and thoracic breathing. The temperature was 100° F., pulse 112, respiration 24. The abdomen was acutely tender, resonant, and distended, without any localizing signs. *Per rectum,* an indefinite bulging could be felt, which was very tender. The diagnosis was general peritonitis probably arising from the appendix.

Operation, 9.20 p.m.—A first incision was made into the lower part of the left linea semilunaris and a quantity of thin pus escaped. A drainage tube with a gauze wick was inserted and the rest of the wound closed. The right semilunar line was then incised and the appendix region explored. The appendix was bound down to the brim of the pelvis and sharply kinked upon itself; its distal half was merely a gray slough. A small quantity of inodorous pus was free among the coils of intestine, and there appeared to be no limiting adhesions. The appendix was sewn into the wound by two stitches and cut off so as to leave about one-fourth inch stump. A rubber tube and gauze wick were left in the lower part. As the child's condition was very bad a pint of hot saline with an ounce of brandy were administered per appendix through a rubber catheter before she left the table. This greatly improved her condition.

February 21: Throughout the night half a pint of saline was administered per appendix every three hours. All was retained. In the morning the large intestine was washed out with two pints of soap and water, a large tube being temporarily placed in the anus. The after-progress was one which gave much anxiety for several weeks. Occasional vomiting, attacks of abdominal pain, and rises of temperature to 102° or 103° F., indicated that the peritonitis had not altogether abated and on two occasions I had to open up pockets of pus which had formed between the coils of intestine adjacent to the right wound. The appendicostomy was used for irrigation of the bowel whenever constipation and distention occurred, and this was invariably followed by much relief. By March 20 the patient was convalescent and the mucous membrane of the appendix was touched with the actual cautery. She was discharged healed on March 29.

This case illustrates very well the value of appendicostomy as a method of relieving intestinal distention as well as of introducing fluids. In it, as is so common in diffuse peritonitis, the colon was tensely distended and almost paralyzed. And though in such a condition it may be possible to introduce fluids into the bowel by the rectum it is often impossible to empty the colic contents by the latter route; whereas by the appendix stoma hot soapy water or turpentine can be introduced under such pressure that the whole contents of the large bowel are washed out, and this is greatly facilitated by the introduction of a large tube through the anus which provides for a ready escape of the fluid.

CASE IV.—Minnie D., aged 23, admitted to the General Hospital March 5, 1909, with abdominal pain. She is said to have suffered from "indigestion" for the past two years. On March 3, two days before admission, she was suddenly seized with severe abdominal pain when she was walking to work after breakfast. She returned to bed and took only fluids, but had no vomiting. The pain had greatly increased the following morning and she vomited several times. She was sent to the hospital as a case of perforated gastric ulcer. The patient was well nourished and had a remarkably placid appearance. The tongue was furred, pulse 132, respiration 24, temperature 100.6°. The whole abdomen was very rigid, but not specially tender. The rigidity was greater below than above the umbilicus. The liver dulness was unaltered and there was no dulness in the flanks. Diagnosis: acute appendicitis and peritonitis. The patient and her friends were averse to any operation as she felt fairly comfortable. During the night her condition became much worse, the pulse rising to 140 and becoming very weak.

Operation at 8.10 A.M. on March 6. An incision first made in the left linea semilunaris gave exit to a quantity of pus, and was drained. The right semilunar line was then opened and the appendix found to be gangrenous with a concretion near its tip. No adhesions were found and there was a large quantity of seropurulent fluid, which welled up from Douglas's pouch. The stump of the appendix was fixed in the wound and the rest cut off. A large tube was passed through the posterior vaginal fornix into Douglas's pouch, and another into the right iliac wound. The operation was concluded at 8.40, by infusing one ounce of brandy and one pint of hot saline into the colon through the appendix opening. The saline was repeated through the same channel every two hours and the patient seemed to rally well from the operation, but later on she rapidly sank and died at 5 P.M.

This short series of four cases represents the most desperate type of illness arising from appendix peritonitis, and the fact that in two out of the four recovery was attained shows a good result of the treatment. A third case would probably have recovered if it had not been for the pulmonary embolism.

One or two further points remain for discussion. The first relates to a comparison between this method and the ordinary one of complete removal of the appendix when accompanied by diffuse suppuration, regarded merely from the point of view of rapidity and simplicity of technical procedure. I feel quite sure that appendicostomy is the simpler method of the two. Fixing the appendix in the wound and cutting it off is simpler than closing the cæcal orifice of the appendix after it has been removed.

Then as to the actual method of performing the appendicostomy, the simpler the details the better. It is generally impossible to preserve the mesentery of the appendix in acute inflammatory conditions, and I have not attempted to do so. The appendix is freed right down to its cæcal junction, and, after fixation by two stitches which pass through its outer coats in the groove between it and the cæcum and through the parietal peritoneum and muscles, it is cut off about one-quarter inch from the cæcum. Two stitches are then passed from its lumen at opposite points and fix it to the skin. These stitches are left long and serve readily to find and fix the stoma for the introduction of the irrigating catheter at any future time. In the first two cases I tied a tube into the appendix stump; but in the last two the stoma was arranged as I have described, and this was found perfectly satisfactory, and it is very remarkable how efficient the sphincter at the base of the appendix proves itself to be, as there is little or no escape of gas or fæces through it after the tube is withdrawn.

When the function of the stoma is at an end it is very readily closed by the application of the thermocautery to its mucous surface.

I would summarize the conclusions to be drawn from the above considerations as follows:

1. The value of appendicostomy in acute diffuse peritonitis is very great in these respects: (*a*) It serves to introduce saline fluid at will in almost any quantity after the operation. (*b*) This introduction is more likely to be efficient than if given by the rectum, especially in children. (*c*) It is less disagreeable to the patient and involves less exposure and moving than does rectal infusion. (*d*) It serves as a ready means of washing out the large intestine and so relieving pain, distention, and the retention of toxic intestinal contents.

2. It is rather a quicker and simpler operation than removal of the appendix.

3. The smallest possible piece of the appendix should be retained, enough to preserve the sphincter at its base, and no more.

4. It is better not to tie in a tube but to reinsert this whenever necessary.

THE APPENDIX VERMIFORMIS.

A NOTE ON ITS PHYSIOLOGY AND SURGERY.

BY CHARLES B. KEETLEY, F.R.C.S.,
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It used to be said that an unfavorable notice of a book in the *London Times* was better than no notice at all, and I think a similar view may be taken of a notice of one's work by Dr. William J. Mayo. That distinguished surgeon, in the ANNALS OF SURGERY for July, at p. 203, expresses himself emphatically as being in disagreement with what he supposes to be the views of Sir William Macewen and of myself as regards the surgery of the appendix.

In the first place, I am not aware that Sir William Macewen is in agreement with myself on the subject, because, on some points in it, he has not published his opinions. But I am quite sure that neither he nor I have said that the appendix should not be removed "unless absolutely necessary to save life." We both believe that many appendices are removed which might wisely be left, and I have attempted to state with precision what appendices the surgeon, for troubles of or about the appendix, is justified in removing. They are "(1) obliterated appendices; (2) tuberculous, actinomycotic, and cancerous appendices; (3) appendices gangrenous or perforated near the proximal end; (4) appendices of which the base cannot be brought up to the parietal peritoneum without undue tension; (5) those of which the meso-appendix is not long enough to permit them to be sufficiently straightened out or to be brought into the abdominal wall without dangerously interfering with their blood-supply; (6) appendices which cannot be placed in good position in the abdominal wall without interfering with such drainage as the case may require. An extremely thick and fat meso-appendix is unfavorable, but not an absolute contraindication." (*The Lancet*, June 29, 1907, and January 2, 1909.)

The only reason which Dr. Mayo gives for rejecting the opinions of Macewen on the functional value of the appendix is that he (Dr. Mayo) "cannot believe that an organ of such exceptional value as they (*i.e.*, Macewen and Keetley) state the appendix to be would so early become atrophied were it endowed with so great a function." I wonder if Dr. Mayo cannot believe that the teeth are organs of value with a considerable function because in most people the best of them become a source of pain and of difficulty in mastication and even of dangerous illness long before the appendix vermiformis is obliterated. The adjectives "exceptional" and "great" are Dr. Mayo's and not mine. The only quality of the appendix to which I have ever applied a strong adjective is its potential surgical value.

And does the appendix become atrophied so early? I have tried to perform appendicostomy in 12 patients of 35 and upwards and have succeeded in 10, only 2 being "obliterated." At such ages as 50, 66, 75 and 78, I found the appendix not atrophied but easily dilatable to any desired extent. In the two eldest patients the appendices were used not simply to admit injections but to evacuate fæces and instead of cæcal colotomy.

Dr. Mayo himself agrees that only 3 to 4 per cent. of adults have completely obliterated appendices. And do not most of the organs of the body depreciate in functional value with age?

Again, the suggestion that I advocate, "the saving of a functionally useless organ which is so diseased as to contain abscesses, stones, etc.," has no justification. Dr. Mayo has probably been misled into this by the cases which I have reported in which concretions were removed and kinked ends amputated and the proximal parts of the appendices afterwards fixed in the abdominal wall. But these organs, after surgical treatment, were neither diseased nor functionally useless. To suggest that they were so is to beg the question and to flatly contradict my statements as to facts in my own published experience.

Sir William Macewen carefully made and recorded observations throwing light on the physiology of the appendix, and he based on them, quite dispassionately, the opinion that the organ has a functional value which claims for it respectful treatment at the hands of the surgeon. I have tried to relate accurately a considerable number of cases in which the appendix instead of being amputated was transplanted into the abdominal wall with excellent results, and I have advised that this practice should be followed frequently, but not indiscriminately.

When will surgeons who do not like my views and do not like Sir William Macewen's, realize that before writing or speaking against them they ought (1) to understand them, (2) to represent them correctly, (3) to put some temporary restraint on ancient prejudice, and (4) to meet fact with either fresh fact, or with disproof. As to Dr. Mayo's final remark that " We are only just beginning to recognize that serious functional digestive disturbances such as pyloric spasm (appendicial dyspepsia), colic, etc., are often produced by a chronically diseased appendix," the fact that chronic appendicitis did cause such disturbances was expressly referred to in my first communication on transplanting the appendix, and I cannot believe that it has not been well known to Dr. Mayo as well as to myself for years. It supports the view that a diseased appendix should not be left in the body unless cured or at least put on the road to cure. But inasmuch as colitis is one of the troubles often associated with the chronically diseased appendix and appendicostomy is often a valuable step towards the cure of colitis, it also supports the view that one should not be in a hurry to cut away a healthy appendix or an appendix which though diseased can be cured.

A distinguished London abdominal surgeon, with the same opinions about appendix transplantation as Dr. Mayo, apparently arrived at in the same way, fell recently into the following absurdity. He recommended for the surgical treatment of chronic colitis (1) among other measures, appendi*cec*tomy, (2) as a last resource, if these failed, appendi*cos*tomy.

CORRESPONDENCE.

THE BEGINNINGS OF THE ANNALS OF SURGERY.

DR. LEWIS S. PILCHER, EDITOR ANNALS OF SURGERY:

You request a brief note from me concerning the part which I was able to take in securing the continuation of the ANNALS OF SURGERY at a very critical period in its history. I had taken a deep interest in the old *Annals of the Brooklyn Anatomical and Surgical Society* from the first, and then watched its elaboration into the *Annals of Anatomy and Surgery* with great interest. In 1882 you did me the honor to make me one of the associate editors, a position in which I continued for a few years. This association led me to realize the difficulties under which you were placed, and the disproportionately small amount of interest which the surgeons and the profession generally in this country showed in the only surgical journal then published in English. In this way I learned of your discouragement, of your difficulty in finding a publisher, and of the probable discontinuance of the journal, which actually did occur for the period of one year.

Just at this time, in 1884, Mr. J. H. Chambers, a publisher of St. Louis, happened to inform me that he desired to issue some other medical publication beside the *Medical Gazette* (which he had bought of Dr. E. C. Dudley, who began it in Chicago), of which I was the editor. (This editorship, by the way, I held until my removal to Buffalo, in 1883.) Later, Mr. Chambers endeavored to publish the *Medical Gazette* simultaneously in Chicago and St. Louis, with the result that after two or three years it became practically a St. Louis publication known as the *Weekly Medical Review,* now the *St. Louis Medical Review.* While talking with Mr. Chambers he displayed ambition to go still further into medical publication and I urged him to correspond with you. I judge that this correspondence was begun at an opportune time, since he shortly after began to publish the ANNALS OF SURGERY, and continued so to do until 1892. Just how great was the service so rendered to you and the profession in securing the revival of the ANNALS after its discontinuance it is for you and for them to judge; such at all events were the actual facts.

Extending to you every congratulation upon the successful completion of a series of fifty volumes which are not exceeded in worth by any other set of equal number and similar character, and esteeming it an honor as well as a pleasure to have been associated with you in some part of its work, and again wishing you a continuation of the same remarkable success which has characterized the past, I am with every good wish,

Yours very sincerely,

Roswell Park.

Buffalo, N. Y., October 26, 1909.

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